L5 NEWS

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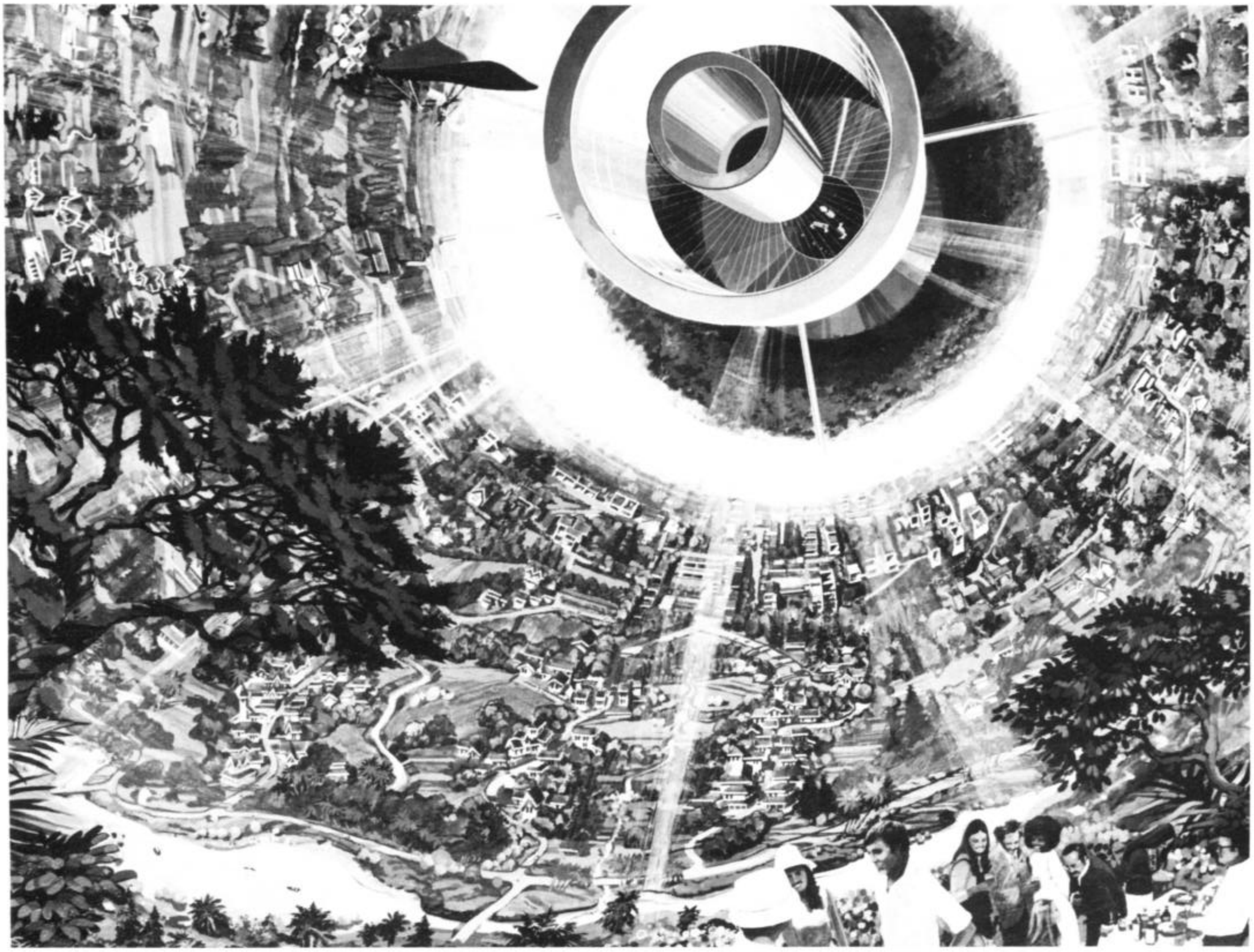

On the Cover: A NASA artist's conception of the exterior of the "Bernal Sphere" space colony, a space-habitat for some 10,000 people. The inhabitants, members of the workforce of a space manufacturing complex, would return after work to homes on the inner surface of a large sphere, nearly a mile in circumference, rotating to provide them with gravity comparable to that of the Earth. Their habitat would be fully shielded against cosmic rays and solar flares by a non-rotating spherical shell, accumulated from the slag of industrial processes carried out on lunar surface material. Outside the shielded area agricultural crops, far less sensitive to radiation than are humans, would be grown in the intense sunlight of space. Docking areas and zero-gravity industries are shown at each end of the space-community, as are flat surfaces to radiate away the waste heat of the habitat into the cold of outer space. In the 1976 NASA Study on Space Manufacturing, just completed, habitats of this type, very efficient in their use of materials for shielding, are thought of as possible next steps beyond more utilitarian structures. These would be shielded versions of the agricultural areas shown here.

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This Page: Interior of the "Bernal Sphere." In this year's NASA Study on Space Manufacturing, habitats of this kind, efficient in their use of materials and structurally strong, are thought of as possible next steps beyond earlier, transitional structures of a more utilitarian design.

The "equator" of the rotating habitat is nearly a mile in circumference, and near it wanders a small river whose shores are made of lunar sand. Natural sunshine is brought inside through external mirrors. Rotation of the sphere at about 1.9 RPM would produce gravity of Earth-normal intensity at the equator, gradually diminishing to zero at the "poles," where human-powered flight and other low-gravity sports would become easy. For the short distances within the space-habitat, automobiles would be unnecessary, and transport would be on foot or bicycle. A climb from the equator past the small villages on the hillsides, to the rotation axis where gravity would be zero, would take about 20 minutes. A corridor at the axis would permit floating in zero-gravity out to the agricultural areas, the observatories, the docking ports, and the industries.

In the economics of space-manufacturing, the provision of attractive living areas of this kind appears to be worthwhile relatively early in the program, because families so located could remain for several years at a time, rather than coming for short tours of duty at high cost for transportation.

CONTENTS

3. J. Peter Vajk: 1976 Summer Study
5. C.H. Holbrow: 1975 Study Report
6. K. Eric Drexler: Another View
7. Ann Elizabeth Robinson: Space Industrialization Contracts Awarded by NASA
7. Carolyn Henson: Sklarew to Head SAI Team
8. O'Neill to Teach at MIT
8. 1000 Women Apply for Astronaut Status
8. Single-Stage-to-Orbit Study
9. Ann Elizabeth Robinson: Satellite Solar Systems, ERDA, and Space Colonization
9. The International Space Hall of Fame
10. Ian Richards, James Kempf: Space Farming: The Debate Goes On
11. Conferences:
    Third Princeton/AIAA Conference on Space Manufacturing Facilities
    Seventh Intersociety Conference on Environmental Systems
12. Jon Coopersmith: Institute on Man and Science Conference Report
13. Keith Henson: Lecture Tour
14. Tom Heppenheimer: Home, Home on Lagrange
17. Spend a Day on Mars
18. Inside L-5
19. Letters
19. Keith Henson: Boosters of Big Boosters, Take Note

LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

L5 NEWS

NUMBER 13 A NEWSLETTER FROM THE L-5 SOCIETY SEPTEMBER 1976

NASA Ames

1976 SUMMER STUDY

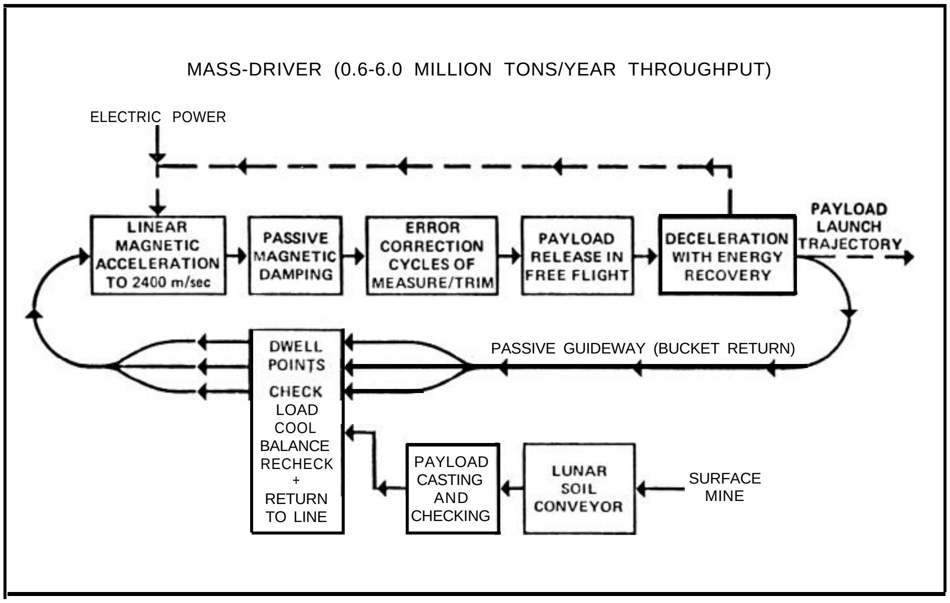
J. Peter Vajk

On July 30, NASA Ames Research Center in Mountain View, California, hosted a press briefing to present a summary of the results of this year's summer study on space manufacturing, sponsored by NASA, Stanford University, and the American Society for Engineering Education. Gerry O'Neill presented a brief overview of the project, and then introduced, in turn, the other four speakers.

Frank Chilton discussed the new design for the Mass Driver which would launch packages of lunar soil from the Moon for use as raw materials in space manufacturing. Basic design parameters included a capacity of 600,000 metric tons per year in 20 kilogram packages accelerated up to escape velocity, 2.4 km/sec, with tolerances in velocity components at release of less than 10 cm/sec longitudinally, 1 cm/sec laterally, and 0.1 cm/sec vertically.

Each "sled" would be subjected to a thrust somewhat smaller than the thrusts required for magnetic levitation train systems planned for terrestrial use, but since these sleds are much lighter than railcars, much higher accelerations would result. Chilton said his team would have designed the system to provide 1000 G acceleration with total confidence that it would work, but O'Neill told him nobody would believe it, so they stuck to only 100 G! (It should be remarked that the Sprint ABM missile accelerates at well over 50 G). The sleds contain superconducting electromagnet coils, with the entire liquid helium system completely sealed tight; the sleds are never exposed to sunlight. Total tracklength is about 4 kilometers.

Since the dispersion between consecutive payloads on arrival at the Catcher, 60,000 km away, must be quite small, the dispersion is still minute only 150 kilometers downrange from launch. If the payloads are initially aimed slightly below horizontal, then final guidance can be provided by letting the payloads fly through a l-meter diameter "tunnel" about 100 meters in length placed on a suitable plateau or mountain 150 km away from release. Fine-tuning to 1mm/sec in all three axes could be provided by zapping the payload with an electron beam and then using electrostatic plates to adjust the velocity. Chilton did not expect, however, that it would be necessary to go to such extremes, as initial release velocities should be within that level of precision anyhow.

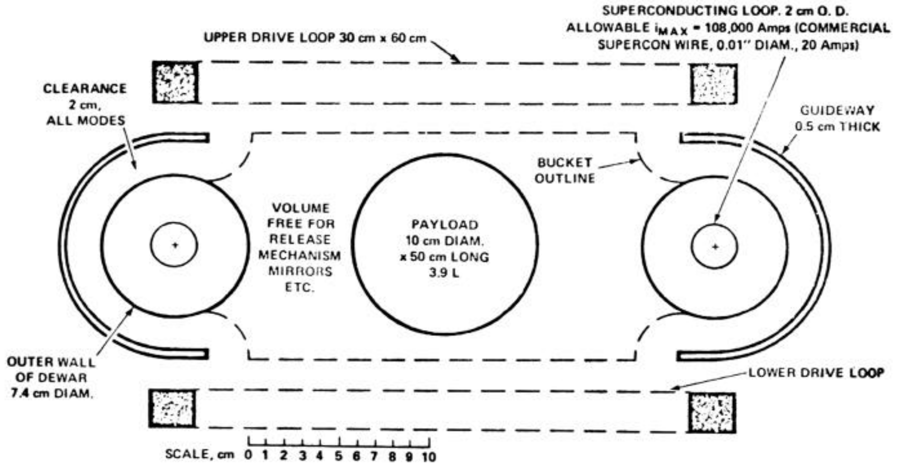

MASS-DRIVER (0.6-6.0 MILLION TONS/YEAR THROUGHPUT)
ELECTRIC POWER
LINEAR MAGNETIC ACCELERATION TO 2400 m/sec
PASSIVE MAGNETIC DAMPING
ERROR CORRECTION CYCLES OF MEASURE/TRIM
PAYLOAD RELEASE IN FREE FLIGHT
DECELERATION WITH ENERGY RECOVERY
PAYLOAD LAUNCH TRAJECTORY
PASSIVE GUIDEWAY (BUCKET RETURN)
DWELL POINTS
CHECK
LOAD
COOL
BALANCE
RECHECK
+
RETURN TO LINE
PAYLOAD CASTING AND CHECKING
LUNAR SOIL CONVEYOR
SURFACE MINE

Total mass for the launch system (including the Rube Goldberg downrange "tunnel") is down 40% from previous estimates. Based on present solar energy technologies or small nuclear reactors, the mass needed would be 4067 metric tons; with extrapolated values for solar energy sources, the mass would drop to 3067 tons. About 100 workers would be needed initially to assemble and align the system, but only about 20 would be needed to maintain and operate it.

Brian O'Leary then discussed the extensive computer calculations which were done to pin down the launch precision required for the Mass Driver. Precision needed depends on the location on the Moon of the launch point. The dispersion in payloads is least sensitive to velocity errors at release if the launcher is placed at about lunar longitude 33.1°. (Looking up at the Moon in the sky, that means the launch point would be about half-way from the middle of the Moon's face to the right limb of the Moon.)

Extensive calculations were also done to define the Catcher's orbit. Because the

NOMINAL PRELIMINARY MASS-DRIVER SECTION
(HALF - SIZE)


SUPERCONDUCTING LOOP. 2 cm O. D.
ALLOWABLE i_{MAX} = 108,000 Amps (COMMERCIAL SUPERCON WIRE, 0.01" DIAM., 20 Amps)
UPPER DRIVE LOOP 30 cm x 60 cm
CLEARANCE 2 cm, ALL MODES
GUIDEWAY 0.5 cm THICK
BUCKET OUTLINE
VOLUME FREE FOR RELEASE MECHANISM MIRRORS ETC.
PAYLOAD 10 cm DIAM. x 50 cm LONG 3.9 L
OUTER WALL OF DEWAR 7.4 cm DIAM.
LOWER DRIVE LOOP
SCALE, cm 0 1 2 3 4 5 6 7 8 9 10

GROWTH VERSION: 41 lb. PAYLOAD AT ρ = 3.0, NO CHANGE IN GUIDEWAY, ~6 Megatons/year @ 0.1 sec HEADWAY)

Moon's revolution around the Earth each month does not keep perfectly in step with the Moon's rotation on its own axis, the launch site does not stay in a fixed position relative to the Lagrange libration points. To minimize the work the Catcher has to do to follow the stream of payloads coming up from the Moon, it turns out that the Catcher should make a once-a-month orbit around L-2 with a radius of about 10,000 km, with the Catcher's orbit standing on edge relative to the Earth-Moon orbital plane. Thus the Catcher would always be visible from the Earth.

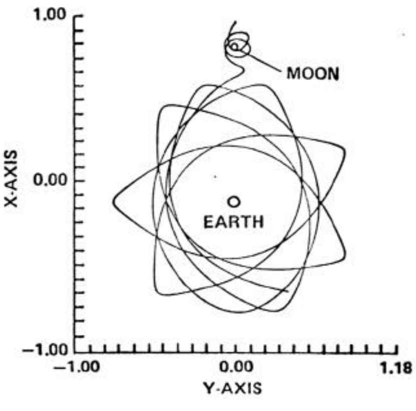
Keeping the Catcher accurately on this orbit requires a "delta-vee" of about 150 m/sec per month, with a peak acceleration of less than 0.2 mm/sec/sec (20 millionths of one-G). To transfer the Catcher and its cargo of lunar soil to L-5 would require an additional "delta-vee" of 440 m/sec and would take about 14 days. Alternative locations were also considered for the Space Manufacturing Facility (SMF) which would be the destination for this cargo. One interesting possibility turns out to be the "two-to-one (2:1) resonance orbit" and transfer there from the Catcher's orbit would require only 9 to 31 m/sec and would take about 65 days.

The "2:1 resonance orbit" is a solution of the restricted four-body problem (Earth, Moon, Sun, and satellite), as are the kidney-shaped orbits around L-4 and L-5 shown in the L-5 Society literature. The orbit is roseate-like, and can be thought of as an elliptical orbit which precesses around the Earth every rapidly, with a satellite in such an orbit returning to the same location relative to the Earth and the Moon every two months. Such an orbit is relatively stable, requiring nominal station-keeping, and has the advantage of a relatively small "delta-vee" to transfer completed power satellites from the SMF to geosynchronous or lower orbits. O'Neill suggested in jest that the L-5 Society might have to rename itself the "Two-to-One Resonance Orbit Society."

William Phinney then discussed the problems of chemical processing in space to extract metals, oxygen, silicon, and calcium from the lunar soil, with some preliminary description of lunar soil composition variations among the six Apollo landing sites. For example, soils from the lunar highlands were relatively more rich in aluminum than were soils from the maria; the converse held for iron.

The kinds of reactions, catalysts, and temperatures needed to separate lunar soil into the desired elemental fractions have been worked out in sufficient detail to think about building a pilot plant to work out chemical engineering bugs. This could be done here on the ground for starters, then in zero-G in low-Earth orbit with the Space Shuttle. Since the processes all begin by melting everything, the physical texture of lunar soils is irrelevant to testing. Pilot plants could be adequately debugged using synthetic lunar soil samples containing appropriate mixes of terrestrially available minerals. Total power requirements for processing 600,000 metric tons per year will be about 500 megawatts, corresponding to about one square kilometer of solar collector area.

TRANSFER TRAJECTORY FROM L2 TO A
2:1 RESONANT ORBIT



Gerry Driggers concluded the presentation with a discussion of fabrication, logistics, timetables, and costs. A careful analysis of what parts of power satellites could be easily fabricated in space at an early stage of space industrialization showed that about 91% of the mass of a silicon photovoltaic cell power satellite could be built in space, with only 9% shipped up from Earth. For a turbogenerator-based power satellite, however, only 68% of the mass could be readily fabricated in space, so that the photovoltaic system appears to have a very strong advantage, at least initially, even if the total mass required for it is significantly higher.

The chemical extraction plant could be housed in a more or less cylindrically shaped "factory" about 50 meters in diameter by about 140 meters in length, while the fabrication machinery would require about a 100 meter extension of that same cylinder.

Three different scenarios were developed for a Space Manufacturing Facility/Solar Power Satellite program. The most conservative was based on "minimum concurrency," that is, development of each part of the system is undertaken only after other parts on which it depends have been fully developed and tested in orbit. The fastest scenario was based on an Apollo-style program, where various logically dependent parts of the system are concurrently developed. By the slowest of these timelines, the first solar power satellite would provide 10,000 megawatts of electricity for the Earth in 1999; by the fastest timetable, in 1992.

To establish the lunar base, operating at 11,000 to 22,000 metric tons per year, well below design capacity, and to establish a prototype orbital manufacturing facility with 300 workers would cost, according to the estimate Driggers considered most reasonable, $30.2 billion. By a highly conservative estimate, the cost might be as high as $63.9 billion.

Working up to a full-scale Space Manufacturing Facility with 6,000 workers, with annual productivity of 5 power satellites of 10,000 megawatts generating capacity, the cost of the project up to the point at which 20 satellites are in operation (total generating capacity 200 gigawatts) would be (reasonable estimate) $102.5 billion to (conservative estimate) $207.4 billion. (All figures are in 1976 dollars.)

Instead of last year's estimate of two years for a SMF to replicate itself, Driggers' team now estimated 2 months; productivity for power satellite construction is ten times higher than last year's estimate. If the entire project were abandoned at the point of 20 powersats in operation, the program would already have proven competitive with conventional ground-based generating plants: the 200 gigawatts would have cost between $500 and $1000 per kilowatt, which is the present cost of powerplants!

L-5 Review: 1975 Study Report

"SPACE COLONIZATION: A DESIGN STUDY"

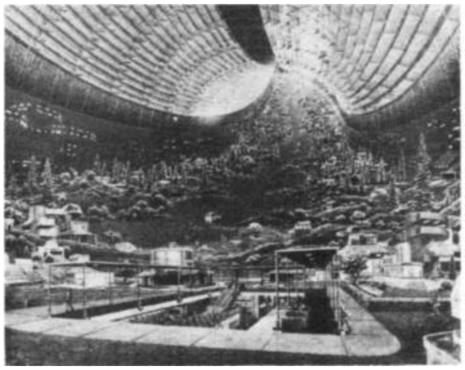
C. H. Holbrow

Where is the long expected report of the 1975 summer design study of space colonization? Well, it's coming. In fact, I recently held in my hand all eight chapters and most of the figures set in galleys with headings, captions and all. But it will be a while vet. The large color figures prefacing each chapter have still to be put in place; the figures need close proofreadings; and then the document has to go through a GPO printing schedule.

I think it will be worth the wait. Representing some six person-years of effort by a team of scientists drawn from economics, sociology, anthropology, biology, aerospace engineering, planetary science, civil, sanitary, electrical, chemical and industrial engineering, physics, and architecture, the report provides the most detailed and circumstantial exposition of the possibility of colonizing space published to date. In eight chapters and many appendices it gives a design for living in space, a program for achieving that design, a number of alternatives, and a wealth of background material useful to those who wish to make their own design.

Except for the wheel shape of the habitat, the design of the summer study draws heavily upon O'Neill's concepts, and so by now the basic proposal is probably well-known to the readers of the *L-5 News.* The plan is thoroughly outlined in the first chapter so that the reader can more easily follow the rest of the report. The 1790-meter-diameter torus is described; it rotates at 1 rpm, at the Lagrangian libration point L-5, and 10,000 colonists live inside the 130-meter-diameter tube of the torus raising their food and living normal lives in a simulated earth-normal gravity. Brief mention is also made of the manufacture of satellite solar power stations for sale to Earth. All this is to be done with millions of tonnes (that's the way we write a metric ton these days) of material brought up to the colony from the Moon in two stages-an electromagnetic launch from the Moon to L-2 where the material is caught, and then by ferry to L-5.

The next three chapters lay out a rationale for the design choices of the summer study group. Chapter 2 describes basic properties of space such as vast distances, gravitational topography, weightlessness, vacuum, intense sunshine, cosmic ray fluxes. Chapter 3 considers their impact on human needs-physiological, psychological, and economic. These needs are defined (e.g. normal gravity, atmosphere, familiar foods, openness of the habitat but with hidden views and variety, a means of earning a living) and various ways to meet them are considered with the aim of achieving a conservative credible design within the limits of "near-term" technology. Anyone concerned about alternatives will find Chapter 4 especially interesting.



Those whose interest focuses on the overall system of the colony and what life in it might be like will be most interested in Chapter 5. Here the reader is taken on a tour through the system. Starting on Earth the reader travels to L-5 and tours the Stanford Torus, its residences, factories and farms. After a visit to the Moon to see the 150 people there mining the lunar soil and maintaining the electromagnetic launcher, you return to Earth. The conversational narrative sticks to the facts of the design. Mention is made of the tedium of life in space, of the long hours and hard work in what is really a small, isolated community narrowly focused on a very few productive tasks. The colony is definitely a frontier community and as such not to be romanticized.

In Chapter 6 schedules and plans for realizing the proposed design are laid out. These naturally lead to the questions of cost and funding. A schedule of funding that would go on over 20 years is presented; the payouts would average about $10 billion per year. By the time the first colony is built, solar power should be producing income, and, about fifteen years later, Earth's initial investment can be fully repaid. All this would be accomplished while building more colonies, more satellite power stations, and paving an annual interest rate of 10% on the investment.

A longer view is taken in Chapter 7. It considers possibilities of using asteroidal material, developing multiplicities of cultures in space, and examines the ultimate limitations on colonizing space.

The final chapter sets out the conclusions of the summer study and recommendations for further research and study. The conclusions are enthusiastic and advocate that the United States, possibly in cooperation with other countries, take definite steps toward colonizing space. Five specific items are mentioned in this connection:
(1) continued development of space transportation, in particular the Shuttle;
(2) start of development of a heavy-lift launch vehicle; (3) the establishment of a space laboratory in low Earth orbit;
(4) the setting up of a base on the Moon where the needed lunar technology can be tested out; (5) an unpiloted, sample-return mission to the asteroids to determine their composition.

There are several assertions of humility in the report to which attention should be called. The actual length of the study was only ten weeks. There was no time for optimization of the design, and in fact the design had to be frozen fairly early on in the process with the result that good ideas with large potential for improving the overall system could not be incorporated. I do not think that any of the participants would recommend building the "proposed" design. By the completion of the study each member could see very radical departures from the proposed design that seemed quite promising. A principal recommendation of the group is that a major systems study be undertaken of space industrialization and colonization.

But even within the terms of the report itself there are some difficulties that should give the careful reader pause. The radiation problem was much greater than expected. To make a habitat safe for long-term living led to a brute force solution of piling 10 million tonnes of lunar slag around the rotating wheel of the torus to protect the inhabitants from cosmic rays and solar flares. Other more elegant possibilities such as magnetic shielding were considered but rejected as unfeasible or beyond "near-term" technology. The colonists end up living in a "cave" built at great expense of effort and resources; they cannot easily look outside the habitat.

There was initially a desire to make the environment as earthlike as possible, but the result is not particularly earthlike. The atmosphere is at half earth-normal pressure; the recycling is almost entirely artificial because natural means are too slow for such a small system; there is no weather; day and night are controlled artificially; the gravity of the system comes from rotational pseudo-forces which produce small effects different from those experiences in a genuine gravitational field. Considerable thought was given to the use of architecture and environmental design to alleviate the artificiality, but there can be no denying or obscuring that colonists would live in city-like surroundings.

Also the engineering problems are very great and stretch technology to its limits. On the Moon cryogenics and superconducting magnets are to be operated near a system pumping megawatts of power into the launching of payloads. All these devices are to be maintained by small crews. There are new designs of transit vehicles, the rotating pellet launchers which each year propel themselves and a million tonnes of lunar material through space by throwing rocks. Their energy is derived from nuclear reactors which power rotating arms. Of even greater engineering difficulty is the catcher which with radar detects and tracks the individual 10 kg payloads coming from the Moon. They are each 40 m apart and moving 200 m/s. A mechanically driven net in one of several large frames about 1 km across must be activated and aligned with each incoming package. The packages arrive .2 sec apart. It's a kind of trap shooting in reverse, collecting together the pieces of a giant clay pigeon.

Another subsidiary goal of the design was to base the transportation on relatively simple extension of existing Space Shuttle technology. In principle the proposed design achieved that goal, but the Table 4.18 which presents expected launch rates shows that the achievement is only in principle. To lift the needed materials and fuels would require about a launch per day with a very heavy environmental burden. Clearly a new generation of lift vehicles is needed for the project to be practical.

Despite a valiant effort to overcome deficiencies of expertise, the report has some serious omissions. There is a complete absence of any consideration of microbial ecology. The report acknowledges this weakness and calls for a strong program of research into the subject. The political problems of founding and organizing a colony get little attention. In general, although there is discussion of the problems of the impact of space colonies on the environments of the Earth and Moon, the demography of a space colony, the esthetics of life in space and the likely attendant cultural shock, the engineering concerns are dominant. Much more needs to be thought about the social and political organization and institutions necessary to foster a good life in space.

The wary reader will surely find other gaps of consideration and treatment, but that should be a large part of the pleasure of reading through this document's riches of fact and conception. There can be little doubt that despite the omissions and potential flaws which are on the whole brought candidly to the reader's attention, this report will serve for a number of years as the principal focus for further creative consideration of the exciting prospect of colonizing space.

ANOTHER VIEW

K. Eric Drexler

In reading and publicizing "Space Colonization: A Design Study" one should know what it is and what it is not. The 1975 summer study suffered from limitations of time, organization, and expertise. The study group favored breadth over thoroughness; the report reflects this by omissions and inaccuracies.

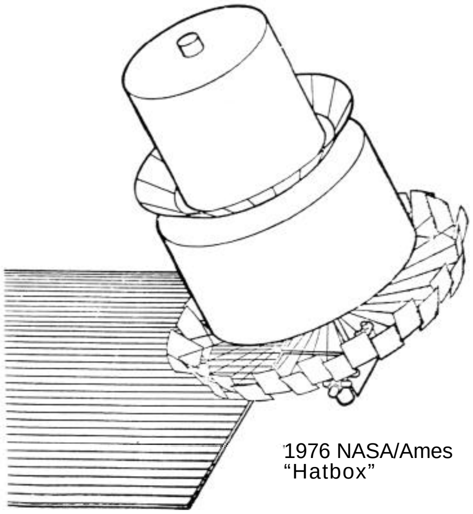
Because of its breadth and starting point, the report can serve as a good general introduction to space colonization. It presents the needed system elements, the motivations behind the project, and the magnitude of the endeavor. Its discussions touch on virtually all the major design considerations of work in the space colony field. As an introductory text, however, it is not as smooth and engaging as some other books now nearing publication. This may be the price of writing by committee.

The report's usefulness as a starting point for future work is questionable. While it contains many ideas, some both new and useful, it has shown many flaws.

As is usually the case, the writings on social and psychological aspects are more opinion than fact. They deal with the uncertain effects of still unconstructed human environment.

The full impact of the design assumptions on space colony economics is not made clear. By lowering esthetic standards slightly (see last month's L-5 News for an artist's conception) and increasing rotation rate (to where an estimated 95% rather than 100% of the population would feel no adverse effects), this summer's study reduced colony structural mass by a factor of four and shielding mass by a factor of three. This affects the sizing and economic profitability of the whole system.

As was shown by the MIT study last spring, the stressed-skin structural design of the Stanford Torus is unsound. The design presented in the report would split like a dropped melon when pressurized due to growth of undetectable flaws in the metal and welds.



1976 NASA/Ames "Hatbox"

The mass driver design has been superceded by this summer's work, which demonstrated that all performance parameters could be improved without significant pressure on current technical abilities. A side effect of this is elimination of the complex active mass catcher through reduced payload dispersion. A further side effect is the replacement of rotary pellet launches by low-throughput mass drivers for space propulsion.

The metal refining system has also been superceded by this summer's work, which demonstrated that the system's mass payback time could be reduced by a factor of four while recovering a greater fraction of lunar rock as useful materials. Partly as a result of the above considerations, the estimated program cost has dropped by roughly a factor of four.

The agricultural system was subjected to a detailed mass balance, but the underlying assumptions approach the ridiculous. A goal was dietary diversity; a sub-goal was provision of a variety of meats (in addition to eggs and milk). While omitting whale meat and lizard meat, the study diet included equal amounts of trout, rabbit, beef, and chicken. While rabbits may be raised in stacked wire pens and fed alfalfa, trout require large volumes of clean, flowing, heavily aerated (not provided for in the space farm design), refrigerated water, and are carnivorous by nature. They might pass on the luxury market. Economical cattle raising depends on vast tracts of land good for little else, a condition unlikely to exist in space for some time. Chickens require virtually the same diet as humans, hence are difficult to justify as a major part of the food chain. The diets proposed for ruminants (soybeans?) take little advantage of these animals' ability to convert agricultural wastes into high-protein food.

A major goal of the 1975 summer study was to provide participants with an educational experience. While I cannot speak for others, it provided such an experience for me.

**A POINT
TO REMEMBER:
L-5**

SPACE INDUSTRIALIZATION CONTRACTS AWARDED BY NASA

Ann Elizabeth Robinson

Rockwell International Corporation, of Downey, California, and Science Applications, Inc., of Los Angeles, have won the negotiation rights for the NASA-sponsored study on space industrialization. For all practical purposes, the two companies have won the contracts; the right to negotiate means that the details of the contract have to be finalized by both the company concerned and NASA.

Twelve organizations submitted proposals to NASA by the June 29, 1976, deadline: Rockwell International: Science Applications, Inc.; Arthur D. Little; Battelle Columbus Labs; Econ, Inc.; Hudson Institute; Northrop Services, Inc.; the Polytechnic Institute of New York; Space Colonization, Inc.; Stanford Research Institute; University of Arizona; and Boeing Aerospace.

The NASA statement of work for the project was publically announced on May 28 by the Marshall Space Flight Center (MSFC), Huntsville, Alabama. MSFC is the NASA center in charge of administering the space industrialization study contracts.

Mr. Claude Priest, the Contracting Officer's Representative for the program, commented on the major objective of the study: "The main objective of this planning study program is to develop an evolutionary space industrialization program which could lead from the shuttle, space lab, and early space station experiments to the permanent practical, commercial use of space."

In a press release issued on Sept. 1, 1976, MSFC stated that outstanding consultants from throughout the country will assist Rockwell International and Science Applications, Inc., in "evaluating and prioritizing the needs, opportunities, and methods for industrializing space."

NASA defines "space industrialization" as "space activities which are undertaken primarily for the production of goods and services which are of major economic benefit to the U.S. and the world. This means utilizing the environment and vantage point of space in a productive and cost-effective way. This envisioned next phase of the space program is in contrast to most space work undertaken to this time, which was primarily for scientific or other exploratory purposes."

The September 1 press release elaborated: "Space authorities are convinced that the state of technology permits and world needs demand that space industrialization accomplishments achieved to date be expanded now into a number of disciplines beyond communications and metereology, in which they have already proven to be highly profitable and beneficial to people"

When asked about MSFC's interest in space colonization, Priest said the interest is very long term-beyond the scope of the space industrialization study now underway. The present study is limited to about a thirty year time period, ending around 2000 A.D.

Priest continued: "What we will seek is a reasonable balance between the bold opportunities of the future, such as satellite power systems and the desire for relatively immediate widespread payoffs of space utilization, such as space processing. Prospective activities include the manufacturing of materials, chemicals, and medicines; the development of new materials and processes; new communications industry; weather services; new earth resources development-ultimately, the movement of people to space for tourism or medical purposes, and the eventual industrialization of the moon."

The space industrialization study is a sixteen-month effort funded by the Office of Space Flight; the total contract value is approximately $400,000, equally divided between two consecutive eight-month, $200,000 segments. Part I of the study will concentrate on "Why Space Industrialization?"; Part II, on "How Space Industrialization?"

Part I of the space industrialization study is being contracted to two different companies at a value of $100,000 each for the eight-month segment. Mr. Priest of MSFC explained: "What we were seeking was two kinds of viewpoints-one from a predominantly systems/hardware-oriented aerospace company, who would bring a hardware development perspective to the study. We were looking for another type of contractor who would be a predominantly research-oriented company, who would bring a non-aerospace/hardware industrial and planning perspective to the study. They would both be working at the same study scope, but would be bringing two different perspectives to the study-the difference being that one company's perspective would be what comes downstream in terms of hardware. . . the other would strictly be research . . . think-tank."

According to Mr. Priest, NASA will only commit to Part I of each contract. Part II is an option to be exercised prior to the end of Part I of the study. Around January 1, 1977, NASA would look at the results obtained to date; at that time, it would decide whether or not to renew the contracts granted for Part I.

In a recent interview, Jesco Von Puttkammer, Aerospace Scientist and Staff Specialist in the Advanced Program Office of the Office of Space Flight, said NASA has a "pretty good idea of some long range goals-space colonies, people living and doing useful work in space, products, energy." He stated that such goals demand a long range program -- about 25 years and between 150 and 200 billion dollars, which is approximately ten times the cost of the Apollo program. Von Puttkammer commented: "Knowing this, and that the public will not commit to a 25-year program, we have to decide what kind of steps we have to take to reach our goals. Space industrialization is the most efficient way of establishing these capabilities... by making each step in space pay its own way, so the public does not have to pay."

Captain Freitag, Deputy Administrator, Advanced Space Programs, when asked about NASA's 1978 budget proposal for space industrialization and colonization, explained that the details of the 1978 budget are not releasable until after the President submits his budget to Congress. He said, "If it's Ford, that means January; if it's Carter, it may take until April. It usually takes about 90 days for a new President to review the recommendations made by the previous administration."

SKLAREW TO HEAD SAI TEAM

Carolyn Henson

Science Applications, Inc. (SAI) is one of two companies receiving research contracts for NASA's space industrialization program. Ralph Sklarew, a participant in the 1975 NASA Summer Study on Space Colonization, will head the SAI study team, which includes Gerald Driggers from Southern Research Institute and consultants Robert Salkeld, Paul Siegler, G. Harry Stine, and J. Peter Vajk. Driggers, who was a speaker at the 1975 Space Manufacturing Facilities Conference at Princeton, is an expert on propulsion and construction of space facilities. Robert Salkeld, one of the top experts in the field of single stage to orbit and mixed mode propulsion vehicles, is also an expert in operations research and holds a degree in economics from Harvard. Paul Siegler, who edits the *Earth/Space News,* also holds a degree in economics from Harvard. G. Harry Stine, author of *The Third Industrial Revolution,* combines practical experience both in business and many phases of space engineering. Physicist J. Peter Vajk has developed a Forrester-style world dynamics model incorporating space colonization; he is currently writing a book on space colonization for Stackpole.

Sklarew plans to study space technologies which can provide an economic return within the 1980-2010 time frame. "We will try to be objective about the potentials," he said in a recent interview. "We may even conclude that there is nothing beyond weather satellites and communications that's worth doing."

Sklarew's team plans to consider a broad range of space projects in its search for economically viable products for space industry. “We want to find things in addition to solar power,” Sklarew commented, adding that he felt excessive concentration on power satellites was a major weakness of the L-5 concept.

The team’s contract runs 8 months. During that period Sklarew says they will “Look at what can be done in space, constrained only by engineering limitations. Then we will consider what is the need for these products and services on Earth. We will then develop a rationale of what could make an economic impact in the 1980-2010 time frame.

“We will place each of these possibilities into evolutionary programs that make sense. There will be a synergy effect-things will be needed in common to reach these individual goals. When we get to the stage where we have defined several possible programs, each with many goals, we will analyze each program for technical requirements and economic viability.”

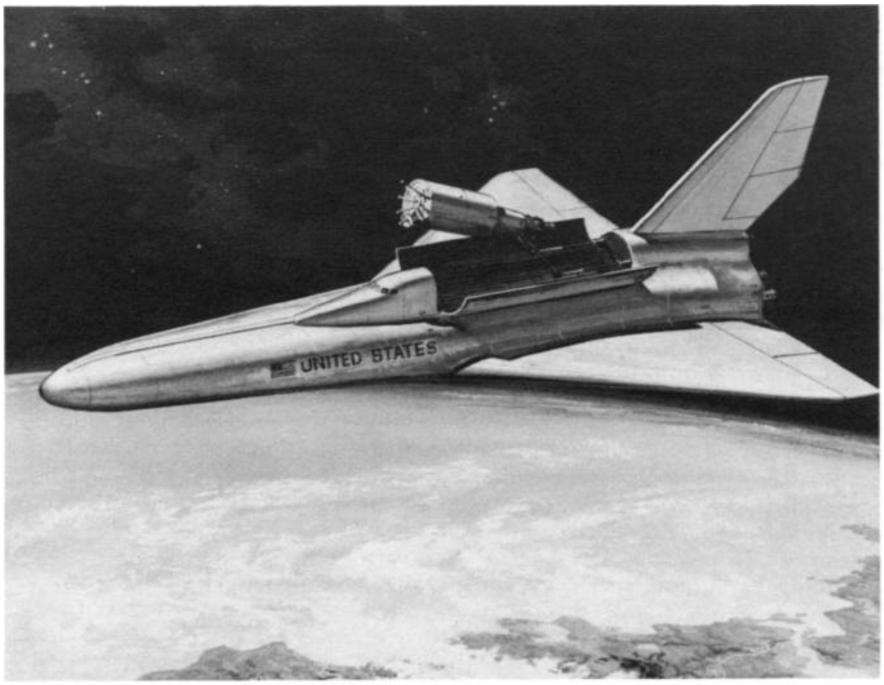
While this is a pretty big goal for a $100,000, eight month study, Ralph Sklarew is confident the SAI team can handle the job: “The biggest problem of the study will not be getting people to do their share, but to get them to stop working long enough to write down their results!”

O’NEILL TO TEACH AT MIT

Princeton Physics professor Gerard O’Neill, on sabbatical this year, has accepted the Jerome Clarke Hunsaker Visiting Professorship in the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology.

Eric Drexler, one of the student participants in the NASA/AMES 1976 study on space colonization, will be a research assistant to Prof. O’Neill. Virginia Reynolds, O’Neill’s Princeton research assistant, will also spend the academic year at MIT. Dr. Brian O’Leary, another space habitat researcher, will remain at Princeton.

Boston area members who wish more information on MIT space colonization activities should contact the MIT Space Habitat Study Group through Beverly Hazelton, Department of Political Science, MIT.



SINGLE-STAGE-TO-ORBIT STUDY

Seattle, Washington-The Boeing Aerospace Company is conducting preliminary studies aimed toward the development of a shuttle-type spacecraft which would take off and land much the way an airplane does.

This Earth-orbit transporter-known as a Single Stage To Orbit (SSTO) system-would be designed for use in the 1990s. following a successful NASA Space Shuttle program. It will be designed to offer clear and significant cost/performance advantages over current systems.

The $213,802 contract, awarded by NASA’s Langley Research Center, Virginia, calls for the identification of technologies necessary for the development of this advanced space transportation system.

The transporter, as defined by NASA, would use advanced hydrogen-fueled rocket engines for its main propulsion system. It would take off horizontally with the assistance of a sled, fly into orbit, then land horizontally on a runway.

The Boeing Aerospace Company has been studying the single-stage-to-orbit concept for two-and-a-half years. Andrew K. Hepler, the firm’s manager for advanced high speed transportation systems, pointed out that a single-stage spacecraft would not need to jettison any part of its launch equipment or boosters, thus allowing reuse of all its parts.

Boeing, he said, will propose the use of a unique advanced structural concept which will allow spacecraft reentry into Earth’s atmosphere without the need of ablative material.

The firm visualizes a family of these futuristic land-to-space craft which would be designed for carrying payloads as small as 3,000 pounds (1,361 kg) to payloads as large as the 60,000 pounds (27,216 kg) planned for the Space Shuttle. Fully fueled, a SST0 craft capable of carrying 60,000 pounds would weigh about 2.2 million pounds (997,920 kg).

1,000 WOMEN APPLY FOR ASTRONAUT STATUS

HOUSTON (UPI) -- A thousand women have told the National Aeronautics and Space Administration they would like to become astronauts for the nation’s space shuttle.

Officials are accepting it in stride. “I’ve been pleased with the number of responses and with the quality of people, including women, who’ve responded,” said Duane Ross at the Johnson Space Center’s astronaut recruiting office.

“We’ve mailed out about 4,000 responses to inquiries. I would guess that probably 25 percent of those inquiries have been from the female population.

“They (women) seem to be very pleased that there’s an opportunity for them to enter the space program.”

Ross said his staff had made no tabulation of requests for information since the February announcement that 30 new astronauts including some women would be chosen by July 1978.

The aim is to have them on board for two years of training prior to the next full-scale manned mission, the orbital shuttle tentatively planned for 1980.

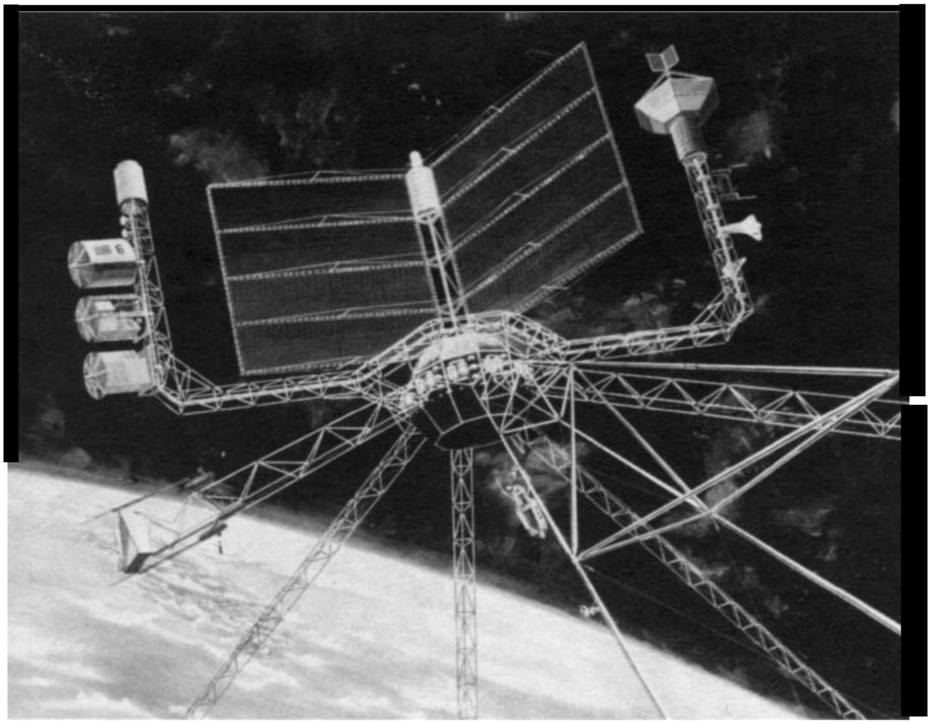
Ross said 30 (15 in an “astronaut-pilot” category and 15 in a “mission-specialist” group) is a minimum number and that more might be selected.

He said many more men and women likely would apply before the June 30, 1977 deadline.

“Most of these people are going to wait until late to apply because it gives you more time to build up your credentials, your academic background, flying time.”

Aside from the selection of women, Ross said, the first astronaut recruitment program since 1967 is similar to six earlier selections that chose 76 trainees, all men.

“I think the approach we’re taking is just about the same. But the requirements are quite a bit less stringent than they have been in the past.”



SATELLITE SOLAR POWER SYSTEMS, ERDA, AND SPACE COLONIZATION:

An interview with Dr. H. Richard Blieden, Assistant Director, Solar Energy Applications (ERDA)

Ann Elizabeth Robinson

In an interview conducted August 31, 1976, Dr. Richard Blieden, Assistant Director for Solar Energy Applications at the Energy Research and Development Administration (ERDA), discussed ERDA's plans for funding solar power satellite (SPS) production and ERDA response to the space colonization approach. He began with a history of ERDA's involvement with the SPS program.

History

"Late last year (1975). the President asked ERDA to look at SPS and place it within the priority of the ERDA programs. Work had been underway within NASA, so, as a first step, a task force was set up within ERDA to review the ongoing SPS work that NASA had done and to make a recommendation to the President and to Congress.

"In the course of this review, there was an opportunity to hear from Dr. Gerard K. O'Neill of Princeton on his concept of space colonization as it applies to the production of power for industrial use." *(Note: On January 19, 1976, Dr. Gerard K. O'Neill of Princeton University, testified before the Subcommittee on Aerospace Technology and National Needs in the hearings on "Solar Power from Satellites." This subcommittee was formed in July, 1975, by the Senate Aeronautical and Space Sciences Committee.)*

The Change of Responsibility for SPS from NASA to ERDA

"The main rationale for SPS is the production of energy for terrestrial use, and, as such, it would be an ERDA decision to proceed with such a project. However, it is important that NASA be involved, because NASA has the expertise for the development and deployment of space power systems. . . . It is a cooperative effort, but ultimately the decision lies with ERDA, based on the energy needs of the nation."

Dr. Blieden commented on the reaction to O'Neill's presentation to Congress. It was ". . . one of considerable interest and something that needs to be looked at carefully. The whole area of SPS is one which needs considerable study and analysis before one can move into a project-oriented phase."

Blieden said that entering the project-oriented phase depends upon trade-offs with other problems ERDA is seeking to address and the resources available -- monetary, people, competition for other major energy projects by ERDA. For example, he said, ". . . if we were to proceed with terrestrial power systems, then resources may not be available for the SPS. . . . I'm saying this is not necessarily the case, but is a possibility. We will be comparing across the board fossil, nuclear, solar, geothermal, ocean thermal systems, and wind systems.

"The ERDA SPS Task Force has made some recommendations which should lead to action on the part of ERDA and NASA. This would primarily consist of the further support and conduct of studies of the SPS concept. Over the next year, ERDA will look at the various energy concepts and determine major problems and potential advantages. We have to answer a number of questions before moving into a project-oriented phase."

Blieden stated that, according to various studies by NASA and independent researchers, power from SPS will be available no sooner than the year 2000.

"A number of technologies under study have a lower front-end cost, but they may lack the advantages of SPS. ERDA needs to answer some fundamental questions about SPS -- such as, where does the orbiting system application fit into the energy system of the country?"

Blieden said the results of the next year's study could range from continuing or stopping the study effort immediately, proceeding at the level of further studies, or proceeding with a specific project and time scale. He offered no speculation as to which is the most probable direction, as he has not yet seen the results of the SPS Task Force. Dr. Blieden, however, did say that some of the results of the Task Force are now available.

Dr. Blieden made a closing comment on space colonization: "It's certainly an interesting concept. At the current time, the support for the O'Neill approach is under NASA's guidance in the Advanced Programs area of the Office of Space Flight. In view of the mandate of that program (i.e., Advanced Programs) that would appear to be the proper place for the O'Neill concept to be supported."

THE INTERNATIONAL SPACE HALL OF FAME

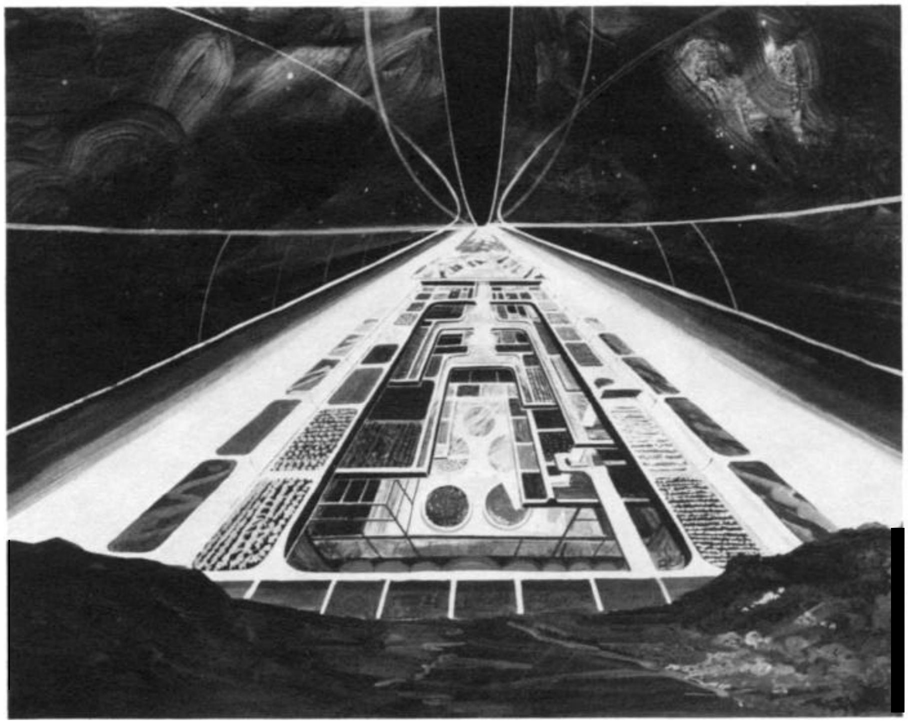
On October 5, 1976, in the presence of notables, scientists, and people from all over the world, the doors of the International Space Hall of Fame will be opened with an impressive ceremony that is not only part of the program of the International Academy of Astronautics where more than 450 international space scientists will discuss the past, present, and future in space. . . it is also the official Bicentennial Event for the City of Alamogordo, New Mexico.

Outside the building in the clear, dry New Mexico desert air is a growing display of historic space launch vehicles and spacecraft. . . some of them the last of their kind. Future plans call for display of launch vehicles from all world nations who have operated them.

Inside the International Space Hall of Fame building, space pioneers of many nations will be honored at the opening. It is planned to add additional individuals each year. The individuals honored have been and will be chosen with the assistance of the International Academy of Astronautics. The identities of the first space pioneers will not be revealed until the opening ceremonies.

For additional information contact the Alamogordo Chamber of Commerce, P.O. Box 518, Alamogordo, New Mexico 88310 U.S.A.

SPACE FARMING: *THE DEBATE GOES ON...*



An artist's conception of the agricultural area of a space colony, designed by the NASA-Ames/Stanford 1975 summer study. The area is shown situated between two parks on the top four levels of the farm, soybeans, wheat, sorghum and some other crops would be grown. The bottom level is a drying facility. Water would be supplied directly from the river and indirectly through the fish tanks that line the sides

SOIL CULTURE vs. HYDROPONICS

Dr. Ian Richards

James Kempf (July *L-5 News)* advances the case for hydroponics for colony food production, stressing advantages of yield and convenience over soil culture. He gives yields of eight crops compared under soil conditions and hydroponics. While I have little direct experience of all these crops, the yield given for potatoes grown in soil (3 tons per acre) is quite unrealistically low.

The usual seeding rate for potatoes is around 1 ton per acre so this yield is equivalent to three small tubers per plant! In the UK, average yields are about 15 tons per acre. It is quite easy, by irrigation and pest control, to achieve 40 tons per acre or more, and optimization of fertiliser rates would probably increase yields further.

In the experimental program of the Company for which I work, we regularly achieve a state in the field for many crops where the yield-limiting factor is input of radiant energy, rather than anything to do with the soil or nutrient supply. Under these conditions a change to hydroponics would be unlikely to increase yield.

The point is that for full growth, plants require certain amounts of nutrient elements-provided these are supplied, it matters little how. Yield advantages of hydroponics over field culture are more likely to be due to exclusion of pathogens and to closer environmental control in the hydroponics system. On a colony, the same care could be applied to soil culture.

However, the apparent conflict between soil culture and hydroponics may not really exist. As Kempf states, hydroponics is essential if materials must be transported from Earth as during the initial phase of colonization. At the stage of a fully-fledged colony of 10,000 people, there will be extensive use of lunar material and soil culture becomes more attractive.

James Kempf also mentioned accumulation of organic matter in cultivated regolith and this may be roughly quantified. The rate of accumulation of an element i in the organic form (Oi) is given by:

$$\frac{dOi}{dt} = RI - RD$$

where RI is rate of addition of Oi, and RD is rate of mineralization of Oi.

RD is likely to be related to Oi by a function of the form:

$$RD = aOi^{b} \qquad (1)$$

a and b are constants and b is likely to be greater than 1.0. Thus:

$$\frac{dOi}{dt} = RI - aOi^{b}$$

If RI remains constant, Oi reaches equilibrium when:

$$aOi^{b} = RI$$

and the equilibrium level of Oi is:

$$(RI/a)^{1/b}$$

Nitrogen is one of the most important constituents of soil organic matter. Equation 2 derives from a small amount of data collected at North Wyke and Rothamsted Experimental Stations (both UK). The amounts of organic nitrogen in soils were measured and the quantities of nitrogen mineralized were estimated from crop nitrogen uptake and leaching losses.

$$\log_e RD = 1.963\log_e Oi - 9.923 \quad (2)$$

$r = 0.931$ residual $SD = 0.349$ P 0.001

RD and Oi were on a g/m^2/year basis

Equation (2) may be expressed:

$$RD = 0.000049\ Oi^{1.963}$$

If we assume RI = 20 g/m^2 year, then at equilibrium, Oi = 722 g/m^2. The rate of attainment of this level can be estimated. In year t, the level of Oi is:

$$Oi_t = Oi_o + RI - aOi^{b/(t-1)} \qquad (3)$$

where Oi_o is the level of organic nitrogen in year zero (itself zero for lunar regolith). Combining equations (1) and (3) provides a crude dynamic model of organic nitrogen accumulation. For a constant value of RI = 20 g/m^2/year, the rates of change of Oi and RD are shown in Fig. 1. The process of accumulation of organic nitrogen is clearly long-term, and soil in the colony might be expected to evolve over many decades. However, values of a and b in equation (2) derive from a limited amount of terrestrial data; their values would be affected by the lack of winter seasons on a colony and by the species of micro-organisms chosen for inoculating the soil. The value of RI also affects the rate of attainment of equilibrium.

The accumulation of organic matter would not increase substantially the amount of soil per unit area. Soil organic matter typically contains around 5% nitrogen and, in the example above, the final level of organic matter would be only around 14kg/m^2.

REPLY TO DR. RICHARDS

James Kempf

The conflict between hydroponics and soil cultivation is actually more apparent than real, as Dr. Richards has pointed out. For the immediate future, the cost of lifting biomass from the Earth with projected lift systems will probably limit agriculture to a system with a low requirement for biomass and a short recycling time, namely hydroponics. Once the lunar mass driver and lunar mining facilities have been constructed and construction of large scale habitats at L-5 is underway, soil farming becomes a possibility. The time scales for the implimentation of the two systems are thus of different orders.

According to Dr. Richards' calculations, the time which would be required to build up organic nitrogen in lunar soil is upwards of 20 years and would involve a final level of soil organic matter (after about 100 years of soil evolution) to about 14 kg/m^2 of agricultural area. If one figures on 250 m^2 which Dr. Richards has cited as necessary to feed a single person, a final level of organic matter of some 3500 kg/person would be required (vs. about 200 kg/person for a hydroponic system), plus whatever amount is stored as food, unrecycled biomass, carbon dioxide in the atmosphere, etc.

At shuttle lift costs ($180 per kilo), lifting enough organic matter to supply a soil farm would cost over eighteen times as much as for a hydroponic system. Since carbon, hydrogen, and nitrogen are rare on the moon, most organic matter for initial habitats must be lifted from Earth, until exploitation of carbonaceous chondrites in the asteroid belt can be arranged. Hydroponics becomes more cost effective than soil farming, but considerations of soil farming are not premature, since extensive landscaping of the habitats, if it is deemed desirable, will involve just such calculations as Dr. Richards has presented.

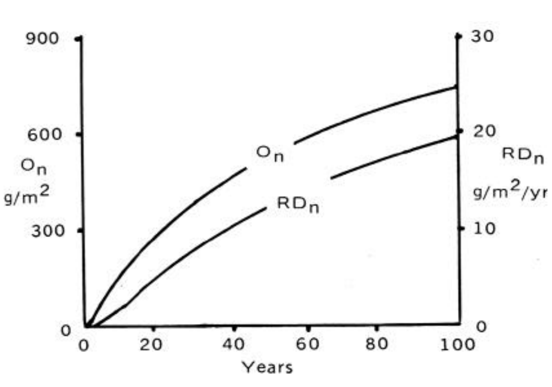


Fig. 1 Changes in 0_n and RD_n with time

conferences

THIRD PRINCETON / AIAA CONFERENCE ON SPACE MANUFACTURING FACILITIES

May 10-13, 1977
Princeton University
Princeton, New Jersey

Abstract Deadline:
December 1, 1976

The Third Princeton/AIAA Conference on Space Manufacturing Facilities (including space colonization) will be cosponsored by the Princeton University Conference and the AIAA. Its purpose is to provide a forum for papers of substantive content, in both technical and relevant nontechnical areas, to consolidate in a single meeting and in a single publication the many and often disparate studies and research efforts which have been undertaken in this rapidly growing field since the previous Conference was held in May 1975. It is expected that the Proceedings of the Third Conference will provide the definitive technical and non-technical basis for accelerating the evaluation of large manufacturing facilities located in space. Papers are solicited in the specific areas of "Space Manufacturing Facility (SMF)", "Assembly and Maneuvering of Large Structures in Space," "Propulsion and Transport," "Mining and Materials Processing, " "Applications for Large Space-based Facilities," "Economics (Including Applications)," "Life Support," "International, Political, and Legal Considerations," "Anthropological, Sociological, and Esthetic Implications"; however, relevant papers of high quality which do not fit within these specific topical areas will be considered for acceptance by the Program Committee.

Prospective authors are invited to submit abstracts of 500-1.000 words or preliminary drafts of final papers for acceptance review. These abstracts should be prepared in accordance with the "Instructions for Preparation of Meeting Abstracts" appearing in the *AIAA Bulletin,* September, 1976, and three copies must be submitted by December 1, 1976 to the Program Committee Chairman: Dr. Gerard K. O'Neill, Department of Physics, Jadwin Hall, Room 302, Princeton University, Princeton, New Jersey 08540.

Authors will be notified as to acceptance of their papers about January, 1977. Authors of accepted papers will be expected to submit photoready manuscripts no later than March 18, 1977.

7th INTERSOCIETY CONFERENCE ON ENVIRONMENTAL SYSTEMS

July 11-14, 1977
San Francisco, California

Abstract Deadline:
December 1, 1976

This conference is sponsored jointly by the Society of Automotive Engineers (SAE), the host Society, the American Institute of Aeronautics and Astronautics (AIAA), the American Society of Mechanical Engineers (ASME), the American Institute of Chemical Engineers (AIChE), and the Aerospace Medical Association (ASMA). The General Conference Chairman is Dr. J.M. Spurlock, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, GA 30332.

The Conference is open to participants from any nation. Individuals who wish to present a paper need not be affiliated with any of the sponsoring societies. Proposed papers will be evaluated solely on the basis of their suitability for inclusion in the program.

There will be four days of technical presentations, with at least one morning and one afternoon session every day. Each session generally will be limited to six papers. Contributed papers are solicited for all sessions listed below. Authors who wish to contribute a paper must submit for evaluation a summary of approximately 200 words (or a full-length manuscript), in accordance with the abstract preparation instructions of any of the sponsoring societies. Three copies of these summary abstracts are to be submitted to the responsible program chairman. Each abstract should include a list of names, affiliations and mailing addresses of all authors.

Section topics and responsible program chairmen are:

Topic Area I: Marine Technology and Applications for Effluent Control, Environmental Control and Waste Management
Session Organizer
Mr. Paul Schatzberg
Naval Ship R&D Center
Code 286
Annapolis, MD 21402

Topic Area II: Advanced Technology for Spacecraft EC/LSS; Personal Protective Systems; and Waste Water Reclamation
AIAA Program Chairman
Dr. Stacy Hunt, Jr.
General Electric Co.
P.O. Box 8555
Philadelphia, PA 19101

Topic Area III: Space Shuttle and Regenerable Shuttle Environmental Control Systems and Regenerable Life Support System Evaluation

ASME Program Chairman
Mr. Franz Schubert
Life Systems Incorporated
24755 Highpoint Road
Cleveland, OH 44122

Topic Area IV: Spacecraft/Missile Thermal Control, Environmental Control and Thermal Protection Systems (papers can involve ground or space applications for missiles or spacecraft; or thermal control aspects of terrestrial energy systems, their management and conservation. Papers can cover results of analyses and/or tests in support of research, design development, and production or implementation); and Aircraft Environmental and Thermal Control Systems

SAE Program Chairman
Mr. P.B. Cline
General Electric Co.
3198 Chestnut Street
Room 3700 D
Philadelphia, PA 19101

Session Co-organizers
Mr. J.I. Gonzalez
Martin Marietta Aerospace
P.O. Box 5837
Mail Point 129
Orlando, FL 32805
and
Mr. John G. Roukis
Grumman Aerospace Corporation
Dept. 410; Plt 35
Bethpage, NY 11714

Topic Area V: Chemical Engineering Applications in Life Support Systems

AIChE Program Chairman
Dr. Robert C. Reid
Dept. of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, Mass. 02139

Abstracts for papers which fall outside the above session topics will be considered if of sufficient merit and should be submitted directly to the General Conference Chairman.

Offers of papers must reach the listed Program Chairman no later than December 1, 1976. Authors will be notified of papers or abstract acceptance by January 23, 1977. Authors of accepted papers then must submit three copies of manuscripts to organizers for review by February 16, 1977. Final, approved manuscripts are due by April 1, 1977 and will be published by the ASME. Late papers will be rejected by the ASME. An author whose paper has not been published will not be permitted to present his paper at the conference.

INSTITUTE ON MAN AND SCIENCE CONFERENCE REPORT

Jon Coopersmith

I was in Rensselaerville, New York, to attend a program of the Institute on Man and Science on space colonies. It was very exciting as we (eighty odd in all) explored some of the human aspects of space colonies for five days.

Before I proceed, I should explain what the IMS is. A non-profit educational center, it explores social problems and possibilities where science and technology are major factors. The institute uses many different methods in attempting this, but always puts people before science. Our conference was an annual event and the actual title was "A Week with Isaac Asimov" which indeed it was.

The format was elegant in its simplicity. We were divided into five groups, each chaired by a volunteer and assigned a resource person. Each group discussed a topic, then presented its findings before a meeting of the whole body. Several of the presentations were quite impressive, being full stage productions.

In his opening, Harold Williams, the Institute president, emphasised that we were here to deal with people-not technical problems. With one significant exception, we did that.

Our group's first task was to determine the degree to which the first colony should represent a cross-section of the American people. We discussed several aspects of this problem, finally deciding that there should be no skewing of ethnic, racial or sexual factors, but that there should be a skewing of age, physical and mental characteristics, as well as a person's educational background.

We also brought forth a few things that seemed, on hindsight, obvious, but had not been mentioned although they were important factors. For instance, the first colonists will probably go through some common training, possibly for a few years. Aside from ensuring that needed skills will be provided, this will also wash out those who are not sufficiently motivated. And when the colonists actually inhabit L-5, they will not all go at once, but will go up in stages. These are small things, but indicative of what we were trying to do.

Another group in the first session dealt with death. This provoked the most intense emotional discussion of the conference. What do you do with the body? Is it just matter or something more? Graveyards are unthinkable, but what about cremation? Or putting the corpse in orbit around L-5? Possibly shooting the body into the sun or out of the solar system (what would happen if an ET found the bodies and became addicted to these frozen dinners?)? Or should we simply recycle the body right away for the greater good instead of waiting a few billion years? I see no "right" answers, but I have a few ideas.

After a delicious dinner (the food was superb) we had a series of speeches. Paul Siegler, the head of EARTH/SPACE Inc., spoke on economic and technocratic perspectives of L-5. He expressed the need to have a diversified rather than a single base to allow for failure, experimentation and better response to needs instead of catering to a rigid plan.

A sociology professor, Paul Meadows of SUNY, speaking about utopian communities, summed up four criteria for long-term success:

1. a sense of mission;
2. an acceptance of the meaningfulness of work (variability of jobs helps);
3. a communalized power structure with control of property, finance and authority;
4. a need for committment mechanisms to (a) instill sacrifice and reinvestment; (b) develop feelings of solidarity; (c) formulate beliefs and principles to unify the colony and explain its justification and meaningfulness

The University of Florida's Bert Swanson posed several questions of a political nature, ranging from Earth L-5 links to the functions and form of the L-5 government. He also solidified our thinking on two important concepts, random selection and random rules of governance. The former is basically an admission that we do not know the answer as to who is the best qualified, though we may know many who are well qualified. In addition, the gene pool is strengthened through diversity, a matter of no small import.

In the latter, interchangeable responsibility is built by having everyone handle a variety of tasks and functions. This is most egalitarian in nature and is a feature of a new society that I feel we should try. A higher redundancy factor is achieved also.

To be honest, I do not recall what our

The CoEvolution Quarterly

HA HA! UNLESS I AM CROWNED KING I SHALL BLOW A HOLE IN THE WINDOW!
NO NO! NOT THAT!
JUST A SECOND!! I LIBERATE THIS COLONY IN THE NAME OF THE P.L.O.!
ARGH NO!

Asimov: "Expert on almost everything."

second task was exactly. I know we produced a wonderfully enjoyable skit and rewrote the question, but I forget what we dealt with exactly. I think that those long social hours which usually extended until four in the morning may have had something to do with this. Basically, we tried to express what we thought would be good characteristics for colonists to have. I won't bore you with our conclusions; suffice it to say that Plato would have been proud.

Another group worked on possible names and, after considering some seven score, selected Chrysalis.

Yet another group, studying design options, developed a novel colony concept. Instead of a cylinder or torus, it is essentially a giant corkscrew, capable of unlimited growth and opening wine bottles several kilometers in length. Most impressive.

Our third assignment after rearranging task groups was to discuss how the educational system should/would socialize the colonists. The main result of this was a demonstration of the power of the group. Over lunch the leader of the government group confided to three of us that her group was proceeding along rather limited lines and not considering several concepts of government that we happened to like. We generously offered to stage a coup d'etat to present these viewpoints, but made the mistake of mentioning this to the rest of our group. We were, to put it mildly, put down in our places.

Our fourth question dealt with the population mix of L-5. Will it be mostly permanent or transient in nature? Is L-5 a stepping stone, an observatory or a colony first? What proportion of transients should there be?

Other groups dealt with property rights (should there be any?), the rights of children, childrearing possibilities -- well, you have the general idea. We explored-not too deeply, but we did explore-some of the less thought out aspects of an L-5 habitat.

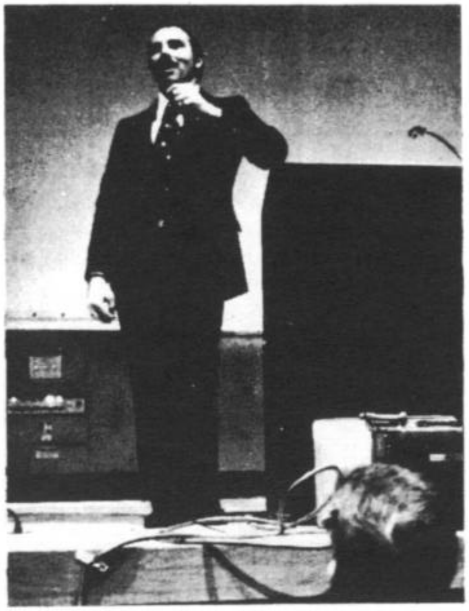
Several things are clear from the conference. A lot more thinking is going to have to be done over a very wide range of subjects. Designing a new world-a viable new world-is more complicated than it seems. For example, human rights as we perceive them in our society may have to undergo change. There may be a lessening of the sanctity of the individual.

The form of government remains a volatile question. My thinking is that a dual government will emerge-a technical semi-authoritarian part to ensure the continuance of life support systems and a semi-libertarian part to handle everything else.

Our group experience was excellent -- for five days we worked, ate, joked and lived together in a very congenial atmosphere. We had Isaac Asimov, accurately billed as an "expert on almost everything," and Ben Bova as resource personnel to comment on our proposals and to launch us forth onto other ideas (Isaac, by the way, proposed that a space laboratory be set up to undertake DNA mutation experiments so they would not endanger the earth if contamination procedures failed). We had NASA's Isidore Adler to help us also. People-and the ability to interact-were the heart of this conference. Terri Rapoport coordinated everything very well.

See you either on Chrysalis or at the Institute conference next year!

Lecture Tour



World Con -- Ready to Go

About half of the members of a general audience who have heard a lecture on Space Colonies will raise their hands in response to the question "would you like to go?" Not science fiction fans, though-they respond at about the 99% level.

L-5 Director Keith Henson queried 1500 science fiction fans when he spoke on the Life in Space panel at MidAmeriCon, the 34th World Science Fiction Convention, held over the Labor Day weekend in Kansas City. Henson spoke on the L-5 concept, '76 Summer Study results, the political and popular support for the program, and the activities of the L-5 Society.

Moderator of the panel was L-5 member Jerry Pournelle; other panel members were Joe Green of NASA, who talked about the lack of public support for space programs, especially Mars missions; Larry Niven, who spoke on possible futures on and off planets, and Marion Zimmer Bradley, who spoke on the need to carefully consider the social side effects of space colonies.

Poul Anderson responded to the panel speakers and there was a lively question and answer period, mostly on space colonies.

Austin, too

Thanks to the dedicated efforts of L-5 members Gayle Watson and Harlan Smith (and Dr. Smith's excellent staff), Austin turned out a crowd of about 500 to hear a lecture (by Henson) on space colonies.

Lunar Science Institute

"You mean we could have *tons* of moon rock?"

A hastily called meeting organized by L-5 members Larry Friesan and Jim Oberg at LSI brought out 50 people from Johnson Space Flight Center and LSI. Though initially skeptical, the discussions which followed convinced most of the audience that this is a serious proposal with a lot of technical merit and the stirrings of large scale political support.

The rate at which new members are joining seems to have increased as a result of these lectures.

The Society has several experienced lecturers in various parts of the country. Some travel for business reasons and are available at low cost to the Society. Considerable advance work is required to make these events effective: publicity, scheduling, slide projectors and the arranging of newspaper, TV and radio coverage. This kind of activity is a prime reason for the Society's existence. It also gives a local organization a large step up by bringing together people with interest in L-5 from the community. Write the Lecture Coordinator at Society Headquarters if you are interested.

BIBLIOGRAPHY NEWS

A copy of the complete L-5 bibliography is available from the Society for $1.00. It will also be sent free to anyone who orders publications from the Society.

The society is in the process of gathering permissions to reproduce copies of as many items as possible from the bibliography list. We hope to become a national (and international) clearinghouse for information on space industrialization, satellite solar power, and the permanent habitation of space.

Part 2

HOME, HOME ON LAGRANGE

The first installment of Heppenheimer's story (see August issue) told of the selection of colonists and training procedures at Houston.

In the on-the-job training, some tasks were quite familiar. The manufacture of wire, needed in huge quantities for strengthening pressure chambers, was nearly the same as on Earth. Similarly, there were few changes in the rolling of steel and aluminum plates or beams. One novel process, however, required a good deal of care: vacuum-vapor deposition.

In this process, aluminum structures are built up by being literally sprayed on. The aluminum is vaporized in a furnace, and in vacuum the vapor is made to escape through a small hole. The resulting spray then is directed at a form which rotates past, as if it were paint from an aerosol can. Over time, the form builds up a thick coat of aluminum, which can then be further strengthened with wire.

We had to contend with the problem of weightlessness, because so much of our work was to be in zero-g, yet our training was in Houston at normal gravity. Thus, we spent a fair amount of our time in simulators. These had TV screens and joysticks to be moved by hand, all hooked up to a computer. A trainee would be shown computer-generated scenes typical of actual industrial activities to be encountered in space; he then had to move the joysticks so as to respond appropriately. The joysticks had mechanisms attached to give a proper feel to the motions, as would indeed be experienced in space. The computer-would allow the test to proceed if the trainee was doing things right, but if he goofed, it would inform him of the consequences: YOU ARE TUMBLING ASS OVER ELBOW AT 13.5 RPM or YOU HAVE JUST CRASHED INTO THE WIRE-DRAWING MACHINE AT 20.3 MILES PER HOUR.

Also, some of the colonists were to be engaged in agriculture. In space, they would have sunlight round the clock, available whenever the plants needed it for optimum growth. In Houston, there was artificial lighting to serve that purpose; but apart from that, the setup was very much as it would be in space. The agriculture is very intensive up here; it's the equivalent of a 100-acre farm providing food for 10,000 people. Though this yield is much higher than you get on a farm in Illinois or Indiana, it is only twice the yield of the best greenhouses, in deserts like Abu Dhabi.

The trick is to adjust the growing conditions to what the crops like best. This means adjusting the lighting, temperature, humidity, as well as treating the crops with just the right mixture of chemicals. A lot of the work in Houston was of the nature of experimental agriculture, determining optimum conditions and things like that. One important task was to develop farmers' judgment as to how individual crops were doing. This required practice; a stand of wheat or alfalfa, which in Iowa might win a 4-H prize, by the standards of the colony might be positively sickly.

There was quite a lot of humbug about space agriculture, in those days. Some people pointed out, quite correctly, that on Earth crops are grown within a complex ecology, or web of life. They then stated, quite incorrectly, that crops could not be grown apart from this web. If you take that kind of argument at all far, you find yourself arguing that we can't grow crops without the mealy-bug and the locust and boll weevil. Actually, the scientific basis of agriculture goes back to the German chemist, Justus Liebig, in 1840. He showed that it was a matter of adding the proper chemicals to the soil, and plants would grow. That's all; it's very simple. Actually, though, we have always raised our colony's plants as part of a web of life. The plants grow, and we eat them-there's your web.

I'm getting a bit ahead of the story now, but I can't help bragging about our crop scientists and the wonderful things they've done. Like dosing the crops with ghiberellic acid, for super-fast growth. Or introducing new varieties bred for emphasis on growing fruit, not stems or leaves. We get oranges as big as cantaloupes, and watermelons you wouldn't believe.

Well, about a year after we all got to Houston, it was announced that the flights to the colony were about to begin. We were grouped in batches of 200, and every couple of weeks one of these batches would leave our center in Houston, to go to Cape Canaveral for the launch. For most of us, it was the first chance in a year to see the world outside our earthbound space colony-and, we knew, the last such chance, quite likely for many years to come.

We all had seen space launches, both on TV and as part of our training, but that wasn't quite the same as seeing our rocket up close and actually flying in it. The thing was really impressive. The first stage was as big as a Boeing 747, standing on its tail, and a good deal fatter. The main stage was mounted upon its belly, and looked nearly as large as the Washington Monument, though at 300 feet tall it was, of course, a lot shorter. The top 100-odd feet of it was fitted out as a wide-body spaceliner. There were two decks, each with a hundred couches. We also had partitions which we could draw around the couches, for privacy, somewhat like in the old Pullman cars. There were portholes, and a large viewing area at the nose.

Since we would initially be living in the construction shack, we could not take along all our household furnishings; there simply wouldn't be room in the little cubicles where we'd be living. Each of us was allowed to take 500 pounds, which at least was enough for things like clothing, books, stereo, and tapes or records. The Government announced that it would store the rest of our stuff until the colony was completed and we were ready to move in. At least they had the decency not to charge us for this storage.

The flights out were rather uneventful. There was the flight to orbit, with everyone lying on his couch. After the end of thrusting, the passenger section would separate from its second-stage booster, with a loud bang which used to startle some people. Then a rather strange-looking collection of tanks with a single rocket engine in the middle would approach. This was the space-based rocket, to take us to the colony. The trip took five days.

It was, for most of us, our first experience with weightlessness. There was always a doctor or two on board, to help some of us adjust; you'd see people running round the aft bulkhead, to get acclimatized. The food was okay, and they served steak a couple times-just to let us know what we'd be missing, once we got to the construction shack..

That shack had initially been built in low Earth orbit, and carefully checked out there. It wasn't quite what you'd call a pleasure dome, but it had all the facilities we'd need to build the colony and the powersats. There were large solar-energy systems for power, and an extensive ore-processing plant which would turn out a couple hundred tons of aluminum per day, I believe. There was a construction sphere, a hundred meters in diameter-a closed sphere in which assembly of major components could take place. And there was a cluster of thirty-foot-diameter modules for people to live in. After it was assembled, a bunch of astronauts and other senior types went on board to live, in order to see that it was fit for human beings, and to check out the equipment. These same people were there when we arrived, to make sure we'd quickly be able to get working in it.

Before we could start building a colony, there was a little matter of some housekeeping around the construction shack. We had to strengthen the construction sphere with wire, spun from steel and titanium smelted in the ore-processing plant. This was so the sphere could be pressurized. The project management very thoughtfully had arranged that most of our work would be without space suits, in chambers pressurized with oxygen. We had been introduced to space suits during our Houston training, and they were a hell of a thing to wear. They were described to us as "constant-volume" suits, which supposedly should flex and bend easily, but the only thing that was constant was the volume of our complaints as to how difficult it was to work in them. Anyway, the arrangement was that we would assemble major structural sections in the construction sphere, then move them out into space for final assembly. That way, only for final assembly need anyone work in a space suit.

As I say, we had to strengthen the sphere with wire. We also had to build a thick shell of lunar soil over major parts of the shack, for protection against radiation. This shell also served for storage of lunar materials, since from time to time we would take some of it and feed it to the ore-processing.

Our lunar material did not come to us directly from the Moon, but came in a bit of a roundabout way. In the Oceanus Procellarum there was the lunar base, with its mass-driver. That was, and is, an electromagnetic catapult-I don't really understand the principles involved. It launched chunks of lunar material with very high accuracy, to a point behind the Moon where they could be caught. The catching was done by catcher vehicles, huge, cone-shaped affairs somewhat resembling a sawed-off dirigible both in size and shape. There were two of them, and some fan of the New York Yankees had named them the *Yogi Berra* and the *Elston Howard.* Every couple of months one of them would hove into view-they were self-propelled-and deliver to us about half a million tons of lunar material.

It didn't take long to settle down into a routine. We built the power satellites because that was our job, but we built the colony because it was our future home. There was a master schedule ticking down the days till the colony would be complete and we could move in, and of course everyone knew from day to day just how construction was progressing. It was one of the things that kept our spirits up. We certainly needed all of that we could get, because life in that construction shack really could be quite unpleasant.

It just was too cramped for any real comfort. It made some of us think of sea duty in aircraft carriers, while others were reminded of freshman days at college, squeezing four into a two-man room. We had these little cubicles, each for two people. Since we were big boys and girls, we could choose our roommates, so from that standpoint at least it was okay. The lucky ones had rooms with a porthole. We had these zero-g showers, and zero-g toilets, in which currents of air served in place of gravity. Also, there was zero-g eating.

We got our food at various stores in the shack. Most of it was grown in the shack, after a while. The variety wasn't all the greatest, but it certainly wasn't the freeze-dried crap which they still were serving in the Spacelab missions. And it was a far cry from that marvelous diet, of distilled urine and toasted Chlorella algae, which had been proposed back in the early days of astronautics. In addition to fruits and wheat, we grew lots of soybeans. Some of our chemists rigged equipment to turn soybeans into TVP -- textured vegetable protein -- and they tried to make artificial steaks and things from the TVP, using artificial flavors. I think most of us appreciated their effort, if not their product.

We got real meat from rabbits. We grew alfalfa for their feed, and the fact that rabbits multiply like, well, rabbits, meant that they were another very productive crop. Rabbit meat tastes and handles like chicken, and we found lots of ways to prepare it. Some enterprising guys even opened a fast-food stand, "McPeter's", which served quarter-pound rabbit burgers with cheese.

We also raised chickens, which gave us eggs. And we kept a herd of dairy goats, fed with the leaves and stems of the plants. These goats were chosen because they were very good at producing milk. We got enough milk to have plenty of butter and cheese, not to mention ice cream. It got so we were eating ice cream two or three times a day, and those chemists I mentioned kept whipping up new flavors for us. I guess it was to help boost our morale. But what really boosted it was when some of us learned to run the milk through a still.

Our recreational activities mainly centered around various types of media. We had excellent radio facilities for communication with Earth, of course, so it was easy to make phone calls to our former homes. This has remained true ever since, that there is the policy of making it easy to make phone calls to Earth. Certainly, in those days it was easy enough to get to feeling isolated on an outpost, and a long phone chat then could be much better than a letter from home. The public has always been quite aware of what we were doing and how important it was, and our friends and relations back on Earth were usually very proud of us. After the first colony was finished, quite a few of them were intrigued by our stories of life in space, and came up to join us.

We had a film library of about five thousand movies, on videotape, dating back to the 1930's. We had a library of records and tapes numbering in the tens of thousands. Also, there was a TV and radio station, retransmitting programs sent from Earth. Mostly the TV showed baseball or pro football from the preceding week; it also ran two or three soap operas. Not exactly the Public Television Network, but it suited our tastes. Also, there was a big library of books and magazines on microfiche, with portable plug-in readers that were actually convenient for reading in bed. We used to get new tapes or microfiches along with our mail, on the regular flights up from Earth.

We got our paychecks every week, with Social Security and income tax deducted, of course. The colony administrators had gone to some effort to ensure that the internal economy would not be too different from what we were accustomed to. There was a system of subsidies for the cost of space transport, so that a tube of toothpaste, imported from Earth, cost 79 cents instead of the thirty-odd dollars it would have cost if we had had to pay the actual freight charge. Our food costs were also adjusted so that we paid pretty much what was reasonable. We paid rent of $300 a month for those little cubicles, $400 if it had a porthole-and for what we were getting, that sure was a lousy deal, even though it included the cost of utilities. Our finances didn't really involve paying cash or check; we would have needed too many people minding cash registers. Instead, we used credit cards coded with electronic data, to charge our purchases and expenses with the aid of a computer. Similarly, our paychecks really were notices of the earnings and deductions credited to our accounts. All our banking was by computer, and if we wanted to put money into a bank, that too was handled via communications with Earth. You could go for months without seeing a dollar bill. But the system was enough like the checks and credit cards we all were accustomed to, that it worked okay.

Except for having to live in those cramped cubicles, those years in the construction shack weren‘t bad. We had plenty of work, and the pay was good. Most of us were regularly salting something away, and the microfiche *Wall Street Journal* was heavily read. Of course, we could communicate with our banks by phone or letter (the spacemail rates also were subsidized), to arrange for investment.

After the first few weeks in the shack, we were ready to go ahead with round-the-clock construction. The first powersat took a Year to build; the ones after that went more quickly. The first one, when it was finished, was sent off towards the Moon. That was to provide a great deal of additional power for the lunar base. This, in turn, meant that in due time they would be able to greatly increase the rate of shipping material out to us. The second powersat, and all the ones after, went down to synchronous orbit around the Earth. When the first of these was turned on and began sending down its power, we all stopped work to watch on TV. There was a ceremony with the President, and he was making some sort of speech about a “new inexhaustible source of power”. Really, the TV cameras should have been on us and not him, since we were the ones doing the work; but that’s the way it is.

Those powersats really are beautiful things. If you think of the old clipper ships, you may recall their tiny hulls and tall masts, spreading such huge expanses of sail. That’s what a powersat is like. There are the generator plants, with radiator panels attached, which are a thousand feet across. There also are support structures, which are barely visible at a distance. But largest of all are those huge solar mirrors. The mirror surfaces are nearly two miles across, and each powersat has four or five of them. It’s not the size, though, that makes the powersats impressive. In space there is little perception of distance, and a ten-mile-wide powersat a hundred miles away looks much the same as would a much smaller one, closer in. But those huge expanses of mirror surface, shimmering in the light, with barely visible ripples running slowly across them-those are what sticks in my mind.

We began building the actual colony about the same time as the first powersat. There had been rumors that the program would be changed on us and that we would wind up building powersats only; I think there’d have been a mutiny if that had happened. The main part of the colony was in the shape of a huge bicycle tire, a mile and a half wide, with the rim being four hundred feet wide. To start the construction, we were sent from Earth an actual inflatable plastic form, in the proper size and shape. Certainly it was the largest inner tube ever built.

We inflated it just enough so it would hold its form, in the vacuum, then wrapped it with miles and miles of wire and cable. That was to strengthen it, so we could inflate it some more. Then our vacuum-vapordeposition people went to work. Over a period of about a year, they built up a thick layer of aluminum over the form. Also, our glass workers fitted thick panes into the inner rim. This was so that by placing mirrors in the center of the colony, at the axis of that bicycle tire, it would be possible to reflect sunlight into it. Once that outer shell was complete, of aluminum and glass, we strengthened it with another wrapping of cable and pressurized it up to a normal atmosphere. This meant that when working on the inside, we would be breathing real air again. Also, we removed the plastic form from the inside, to be used in time for building the next colony. Then that shell was slowly spun up to one rpm, to give normal gravity.

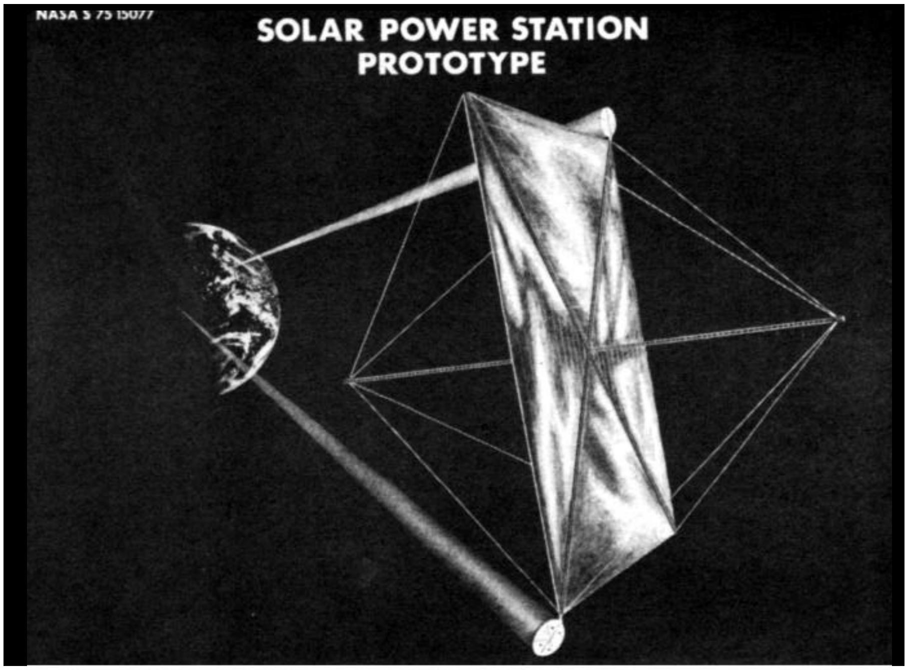
The part that took the longest to build was the radiation shield. If you think of the colony as resembling a bicycle wheel, the shield was the tire over that wheel. It was of ordinary rock and soil covering the whole colony, and six feet thick. There were angled sections with mirror surfaces, over the windowed areas, to let the sunshine through. This shield weighed ten million tons, so it took several years to build. It kept down the level of radiation inside, from solar flares, cosmic rays and whatnot, to about the level of Denver, Colorado. This meant that those of us who wanted to could go ahead and have kids.

We had all along had a few kids in the construction shack. Some were old enough to learn the exercise routines everyone did, to stay healthy in weightlessness. Those who weren’t, were continually fussed over by doctors, and given frequent rides with their mothers on centrifuges so they could see what gravity is like. I think the young babies really were better off for living so much in zero-g. It was somewhat like what they had known in the womb.

Once the main, bicycle-tire portions were completed, the rest went very fast. The agricultural areas, the apartment complexes, the shops and parks, and the central hub with its big spokes to the rim-those all were completed while the radiation shield was being filled. Then some of the main industrial areas of the construction shack were detached and hooked up to the central hub. We built a big radiator, for temperature control, and installed the necessary systems to make the colony run. Then everyone had to wait impatiently until the President could arrange to come up and formally dedicate the colony, before we could move in.

He came up along with a bunch of Cabinet members and Congressional leaders. He shook as many colonists’ hands as he could, grinning all the while for the cameras, and then he made his big speech. He quoted from John Kennedy, and talked about humanity’s never-ending future on the High Frontier. Maybe I’m a bit cynical about politicians, but it really was a fine speech. He said a lot of what we’d been thinking all along. And, of course, it’s nice to see the President supporting so strongly what we had been doing.

Then he unveiled a plaque which stated that our colony was the Morris K.



Udall Center for Space Industrialization. Mo Udall was a Senate leader, who for many years had supported and advocated the colonization of space, working on its behalf even while he was still a member of the House of Representatives. Of course, the real founder of the whole thing was Gerard O'Neill of Princeton University. Starting in the early 1970's he and his associates had developed the major ideas, and in time won enough support in Washington to put it over. Still, O'Neill never was a member of Congress, which is why the colony didn't get named for him.

There was one O'Neill idea which goes back to the earliest studies of colonization, which we all very much appreciated. This was that there should be a lot of effort and attention paid to making the colonies pleasant places to live. From the first, O'Neill had talked in terms of garden apartments, of trees and grass and flowing streams, and of similar pleasing prospects. Unfortunately, he hadn't reckoned with the fact that the architects and designers would be working working for that vast and unimaginative bureaucracy, the Space Industrialization Administration. Still, if we aren't living amid the scenic beauties of O'Neill's early descriptions, what we have is at least as good as anything most of us have ever had on the Earth. And it's a far cry from the construction shack cubicles.

We have terraced garden apartments, with nice rooms, furnished with the stuff we had initially brought to Houston and then left in storage. The bedrooms and family rooms are quite attractive. Most apartments have patios facing out over the colony interior. They were built in a sort of a cluster style, resting on top of each other, but arranged in such a way as to leave room for the patios and for our little lawns. The floors and ceilings are well soundproofed.

We were able to buy small electric carts, similar to golf carts, with which to get around. This meant that even though the colony was as crowded as a major city, it was quiet and free of auto fumes. Also, quite a lot of us have bought bicycles.

It didn't take long before the population began to grow. We set up new day-care centers and began to set up schools, too. The teaching is by TV and radio link to the Earth. The teachers there work with the children a quarter-million miles away, but we try to have real, human teachers to drop in on the children as often as they can.

The space colony really seems to be a good place for children to grow up. There are not a great many kids here, so they're valued and wanted more, quite likely, than if they lived on the Earth. On Earth, children and teenagers often have trouble finding appropriate roles, in societies that don't really need them. But we need ours, to help our society grow, and they know it. From early in their lives they learn what it means to be space colonists, and we see it reflected in their play and in their games, as well as in the way they talk.

So that pretty well brings us up to where we are today. Since those early days in the last century, we've built hundreds of powersats, and half-a-dozen or so new colonies. We've built a settled type of life here. Most of us expect to stay here quite happily, except for occasional vacations back at Earth.

We can take such vacations now, now that there is the new Super-Shuttle. It carries as much payload as the old Heavy-Lift Launcher, but it's completely reusable. So now it's no sweat getting from here down to Earth; and next week, that's exactly what my wife and I will be doing.

Our daughter is already down there, at the University of Michigan. One of these days we're probably going to get a good university up here, but meanwhile we send our bright young people down to the Earth. We'll be visiting her, certainly, but we'll be doing much more.

We've been round the world hundreds of times, but always at high altitude. Now we'll be going around it once more, but this time at ground level. My wife has always been fascinated with Hong Kong. As for me, I'm intrigued with visiting the castles in the northeast of England. So on the next Earthbound flight, we'll be aboard.

SPEND A DAY ON MARS

As the answers to questions hundreds of years old crackle across space to the planet Earth from the Viking spacecraft on Mars, new questions are being raised. Theories concerning the basic ingredients of life are being challenged, changed, and fortified by the Viking Mars missions. The ramifications of the search have broad scientific implications, as well as the philosophical and sociological questions of "Who are we?" "How did we get here?" "Are we alone in the Universe?"

FASST and the American Institute of Aeronautics and Astronautics (AIAA) invite you to take part in a student symposium, "The Search for Life in Our Solar System." The conference is to be held at the Jet Propulsion Laboratory in Pasadena, California, October 8, 1976.

Involved in the program will be:

Ray Bradbury, Noted Science/Fiction Writer: "Evolution of Our Cosmic Perspective"

James Martin and Dr. Gerald Soffen, Viking Project Team: "The Viking Project and First Results"

Jesse Moore, J.P.L. Flight Projects Planning Office: "The Future of Unmanned Probes"

Scientist/Astronaut Dr. Karl Henize, Johnson Space Center: "Manned Exploration of the Planet Mars"

Dr. John Billingham (Special Dinner Presentation) Ames Research Center: "The Search for Extraterrestrial Intelligence."

Participation is directed, but not

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NL609

L-5 SOCIETY
1620 N. PARK AVE.
TUCSON, AZ 85719

NAME: ________________________________

COMPLETE ADDRESS: ________________________________

AFFILIATION (OPTIONAL): ________________________________

TITLE OR POSITION (OPTIONAL): ________________________________

I am -- am not -- interested in being active locally.

__ Back issues of *L-5 News* available, $1.OO each.

__ Please enroll me as an L-5 Society Member. I am enclosing a check for $__________ (regular membership, $20.00; student membership, $10.00; memberships include subscription to *L-5 News).*

__ Enclosed find a donation of $__________ (donations to L-5 Society are tax-deductible).

limited, to college students and faculty. The registration fee is $9.00 which includes a tour, materials and dinner.

For those wishing to participate, send your registration fee with the following information to FASST, 1785 Massachusetts Avenue, N.W., Washington, D.C. 20036: *Name, mailing address, college represented, major field of study, phone number.* Registration deadline -- October 1st.

Inside L-5

The L-5 staff this month included New Yorker Bill O'Boyle; Jim Parker of Covina, California; Eric Drexler of Cambridge, Massachusetts; and Tucsonans Fred Michael, Dennis Riggin, Jim Kempf, Keith and Carolyn Henson, Daniel Lomax, and Jonathon Nix.

Those who wish to come to Tucson to work on the L-5 staff are offered free room and board with the Hensons. The Tucson staff enjoys the stimulation and fresh perspectives of the visiting staff. Visitors enjoy encountering the quaint customs of the Southwest and often comment on the stimulating nature of the contents of the Society's files. The file labeled "Vituperation" is one of the more popular. For an exciting vacation in the balmy winter resort of Tucson, make your reservations now!

CHANGE OF POLICY

L-5 library subscriptions are being reduced to $20 per year. Newsletters are normally priced very high to libraries-if they are available at all-as a library subscription displaces many regular subscriptions. (People just copy them.) But the *L-5 News* has now grown so big it costs more to copy it than to subscribe, so library subscriptions are now to our advantage. We would appreciate it if L-5 members would ask their local libraries to subscribe.

HAPPY BIRTHDAY, L-5 NEWS

This month the *L-5 News* is one year old. That first issue was only 4 pages long. It carried articles on Gerard O'Neill's testimony before the House Committee on Science and Technology; the preliminary report of the 1975 NASA Summer Study on Space Colonization; a quote from Peter Glaser, father of the solar power satellite concept, and an extensive bibliography.

One year later the *L-5 News* is up to the status of a regular magazine and new members are coming in at a record rate. The L-5 staff would like to thank those of you who forked over $20 for membership in the Society back when we were first starting; without you we would have never gotten off the ground. With the continued support of our members, in our second year we can further raise our standards.

Special thanks goes to the many researchers in the field. The Society wouldn't have had much use for members and donations if research on space habitats and industries had failed to show promise.

We also really appreciate the cooperation of NASA in providing the *L-5 News* with artwork, and all our members who have contributed articles and letters.

Writing Letters to the Editor

"What do I have to do to get my letter printed," some members have asked. (1) Stick to one subject. Letters which ramble from one topic to another are hard to read and understand. (2) Be brief. In general, an opinion stated in 500 words is a great deal more interesting than the same opinion elaborated on for 2000 words. (3) Don't call people names. We have a file labeled "Vituperation" for those letters. (4) Get a friend to read a draft of your letter. What appears crystal clear to you may look like mud to a friend. Rewrite until your letter is easy to understand.

ADMINISTRATOR'S DESK

Some of you will be receiving notices that your membership in the Society has expired (or will be expiring). If this notice does not match your expectations as to membership expiration, let us know. Some of the volunteers who made entries into subscription files did not record the effective date of the subscription.

For the same reason, some of you may not receive a notice who should be getting one. If this is the case, please send in your membership renewal, and tell us with what issue of the *L-5 News* your membership began.

The financial base of the Society is memberships. The more members we have, the better service we can provide each member. You may notice that we now have a larger newsletter and are beginning to expand our membership services. This is because of the generosity of a private donor, who has provided additional funding for the Society for a limited period of time. If each current member would find us one new member, we would be able to continue to operate on this level with no additional miracles.

L-5 SOCIETY, LOS ANGELES CHAPTER

Walter and Dorothy Travis will be having a combination swim party, pot luck, L-5 meeting and star party at 6 pm, October 16, at 1000 Wardman Dr., Brea, CA. RSVP: 714-529-5437.

AVAILABLE FROM L-5 SOCIETY

Nontechnical Presentation Slide Set: 16 slides, $6.00

Technical Slide Supplement: 16 slides, $6.00

Slide information for Nontechnical Set: $4.00
(includes lecture material)

Supplemental Slide Set: 8 slides, $4.00

Back Issues of L-5 News: Numbers 1-13, $1.00 each.

CoEvolution Quarterly: Fall, 1975, and Summer, 1976 issues largely devoted to this fascinating subject: space colonization. $2.50 each.

LETTERS

I *would like to suggest* that the L-5 Society consider changing its name to the “Space Colonization Society” for the simple reason of more rapid identification from the general public with the goals and purposes of the Society. I would like to suggest that a vote be put before the Board of Directors regarding their desire to continue the use of the name L-5 Society or, change to the name Space Colonization Society. In addition, an item in the newsletter regarding the proposed change might also be appropriate.

Although I am personally quite familiar with the problems of changing names, I believe that the logo of the organization can be maintained. I fear for the day when another group of individuals forms a separate society utilizing the name “Space Colonization Society” which would then, unavoidably, leave those of us in L-5 far behind as far as membership is concerned.

Sincerely,
David M. Fradin
Executive Vice President
Environmental Balance
Association of Minnesota

How do you feel about changing the organization name from L-5 to Universe Society? Some people get the impression the only place we can build is at L-5. Would appreciate your comments.

Bill Agosto

As a fellow active member of the L-5 Society, I read with interest about our $25 reward “for an interview with either of the candidates for President on the L-5 project.” I quote again the same issue of the L-5 News: ”‘But what does he think the ideal society would look like?’ Brand (tolerantly): ‘He’d say that’s the wrong question, because the answering of it prevents the realization of it. As soon as you’ve got a plan of what everyone wants to do, there’s no way it’s going to happen.‘”

Realizing the overwhelming influence our $25 reward will have on the course of the American Presidential election, I mention the possibility this year of a third major Presidential candidate.

I agree with independent Presidential candidate Eugene J. McCarthy that cuts should be made in military spending (where the money is); I disagree with him about cutting space spending (where the money is not). (Indeed, I support Dr. O’Neill’s space colonization program.) Two close friends of Gene, Governor Jerry Brown and economist John Kenneth Galbraith, apparently also disagree with the Presidential candidate here, while agreeing about cutting military spending. (Whether Rep. Mo Udall would play a role in a McCarthy administration I cannot say at this time.)

Gene has expressed his desire that more decisions be made by Congress or the Cabinet rather than by a single person (no matter how benign) who in America is called President rather than King or Dictator.

Gene is, I feel, the most honest and the most intelligent of the Presidential candidates. When one tries to think in net effects, however, it is difficult. Thomas Jefferson, also honest and intelligent, had always claimed the federal government possessed no right to increase the national domain by treaty. Yet as President he bought via treaty “a scrap of paper” also known as the Louisiana Purchase.

With McCarthy, a compassionate economist and a person of duty and common sense, the American economy and spirit might radically improve. The American spirit and economy may be of major importance re space spending and the L-5 project.

Working for the ideal society and voting for the best candidate sound easy. It is easy to fool ourselves. The proper roles of reason and intuition remain a mystery. Good Working and Good Voting!

Charles E. Tandy

In regards to Dr. Leary’s article in the August ‘76 *L-5 News,* I would just like to say, “He’s right you know.”

Donald C. Flint
member L-5 Society

I was watching Dr. Timothy Leary on the Tom Snyder program a few weeks ago and immediately wondered if he has the support of the L-5 Society. I wonder if having Tim Leary as a vocal ally of the space migration theme will help or hurt the cause. Dr. Leary is not exactly Washington’s favorite armchair philosopher. In fact it seemed to me that if you replaced the words “space migration” in his recent article in the *L-5 News* with “psychedelic experience” you’d be reading an article he might have written in 1968. It’s not that I don’t like Tim Leary, because in ‘68 I was a big fan of his. It’s just that I don’t see him being of any real help to the project when what the project seems to need is friends in Washington. I’m afraid too many people will begin to equate the L-5 project with Timothy Leary and all the negative things he may represent in their minds such as the single most responsible person for the undermining of the nation’s youth in respect to the drug revolution. The L-5 project must not appear in the least as a new way for Tim Leary to Turn on and Drop out. I cannot support Dr. Leary in his new quest for a far out cause that he can be spokesman for.

I’d very much like to know the L-5 Society’s position on Dr. Leary. If you don’t support him I believe it should be so stated in the next issue of the *L-5 News.*

Sincerely,
Jim Ryan
Indianapolis, IN

Dr. Timothy Leary is not a member of or representative of the L-5 Society. However, he has been in communication with Society headquarters (see his article in the August, 1976, L-5 News*), and we have “‘supported” him to the extent of providing him with information on space colonization and materials promoting the L-5 Society, in the same manner as we would act in support of any member of the public who needed assistance in spreading information about the subjects.*

To repeat, however, he does not officially or unofficially represent the Society, and we can take no responsibility for his actions. We printed his article because we felt it would be of interest to our readers; the opinions were his own and not necessarily those of the L-5 Society or staff.

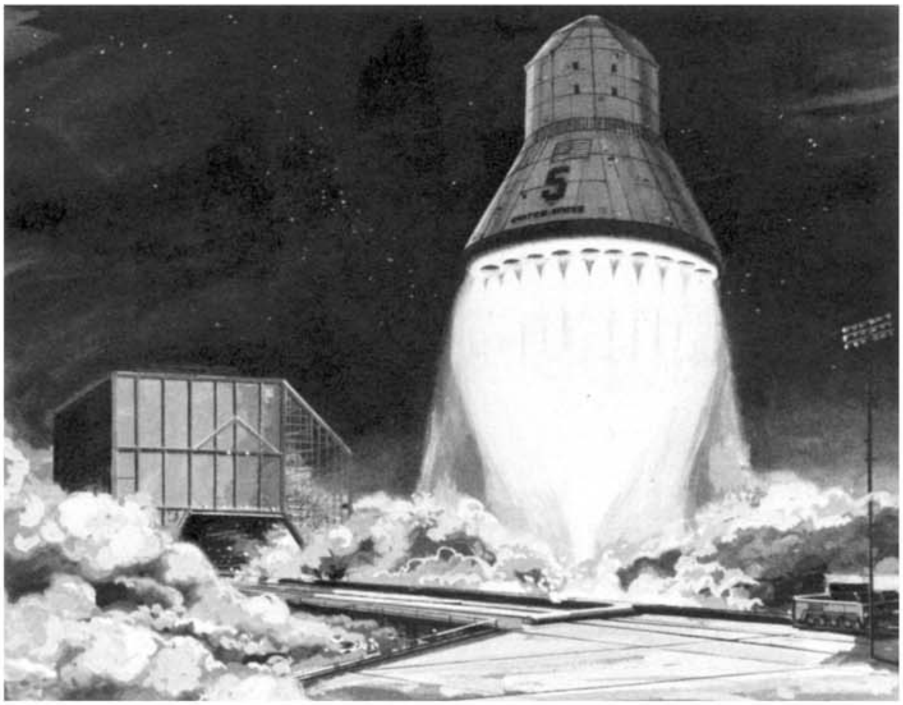
On the other hand, we feel the L-5 project is big enough to accommodate the support of all kinds of people, orthodox and unorthodox.

BOOSTERS OF BIG BOOSTERS, TAKE NOTE!

Keith Henson

A worrysome note to some NASA people has been the tendency of those in the Space Colonization/Space Industrialization (SC/SI) camp to hold forth that the very large boosters (1/2 million pound up) will not be required. They argue that Solar Power Satellites can be built from Lunar materials without without them. This may, or may not be true, but if the big boosters come first, SC/SI will look much better economically because of the reduced front-end transportation cost. Alternately, if SC/SI can be made to pay at all with Shuttle and Shuttle-derived vehicles, then it’s clearly worth while to build the big ones to take over the freight load as soon as possible. SC/SI as we see it now has to take a radical step to lunar resources to make sense, but if it does, the transportation system can evolve just as aircraft have evolved from DC-3s to 747s. A very interesting concept to consider is building the Heavy Lift Lunar Vehicles in space by vapor deposition (the metallurgy is well understood). Absolutely seamless tanks and shapes can be deposited on inflated forms at low fabrication cost, and foamed metal is a distinct possibility. Best of all, a lot of you would have to be on hand, and I haven’t met a rocket engineer who wouldn’t jump at the chance to go.

(See illustration on back cover.)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UNITED STATES

LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

L5 NEWS

NUMBER 16 A NEWSLETTER FROM THE L-5 SOCIETY DECEMBER, 1976

SATELLITE SOLAR POWER STATIONS

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SPACE SOLAR POWER

Excerpted from Grumman Aerospace Horizons.

Investigations performed by Grumman Aerospace Company and its associates -- Arthur D. Little, Raytheon, and Spectrolab -- over the past five years indicate that space solar power is feasible and economically practical. The collection of solar energy in Space at the preferred synchronous orbit (22,000 miles above the equator) is essentially continuous. No storage systems are required, in contrast to ground-based collector systems.

The Satellite Solar Power Station (SSPS) design calls for a large space solar power collector, assembled in space, to be stationed in a geosynchronous orbit (one that makes the SSPS virtually fixed over a given point along the equator). From this orbital position it would transmit the collected solar power via a microwave beam to a six-mile-diameter receiving antenna, or rectenna, on the Earth. There the microwave energy would be converted to electricity and fed directly into the power grid.

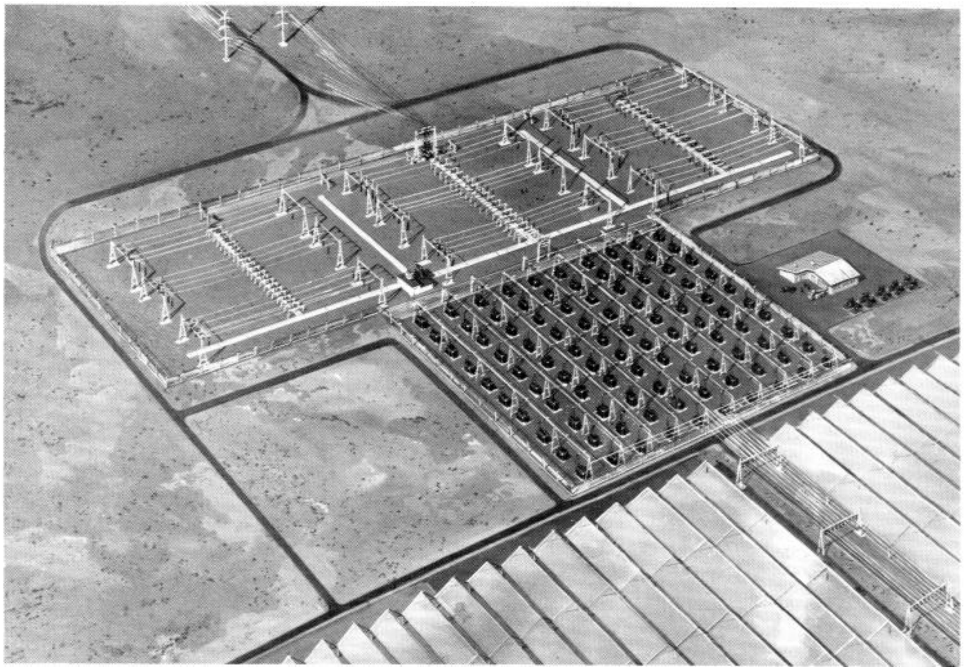
The station itself consists of two large rectangular solar panels, each measuring approximately 3½ miles long by 2¾ miles wide by 200 yards deep, interconnected by a single large mast. Centered between these solar panels is a microwave antenna some 900 yards in diameter.

Mounted on the huge panels are vast arrays of solar cells, making these solar panels very much the same in every respect but size as those used to power nearly every spacecraft and satellite to date.

The solar cells are laid out in vast arrays along the bottom surface of each depression in the solar panel structure. To concentrate additional sunlight on a solar array, the immediately adjacent sides of the structure are covered with a reflectively coated sheet of lightweight Kapton plastic. Thus, as the panel is bathed in the Sun's rays, the solar cells receive both the direct radiant energy and that reflected from the Kapton-lined sidewalls, effectively doubling the amount of solar energy absorbed by the cells.

Each solar cell, through a photovoltaic process, converts the Sun's radiant energy to direct-current electricity which flows along the conducting panel structure and mast to the microwave antenna. The rotatable antenna transmits a beam of microwave energy to the receiving station on the ground, where it is converted to usable electricity.

There is relatively little energy loss in this transmission, and the power can readily be generated at frequencies that preclude interference with other bands. Microwave energy can also be transmitted through clouds and heavy rain with less than a five percent loss. It is also safe.



Rectenna array over farmland (lower right) receives microwave transmission, and inverters (center) convert it to usable electricity which is distributed over conventional power transmission lines.

Siting studies indicate that the rectenna is best located on low-value land or offshore near large metropolitan areas. Actually, a key advantage of space solar power derives from locating the rectenna near the power users, thereby minimizing the transmission costs. Of course, with solar power you also avoid the need for mining equipment, delivery trucks, and other costly elements.

The heart of the SSPS system concept is the solar cell and the microwave link. Solar cells today can deliver electric power with an efficiency of 13 percent; in the future we can reasonably expect to get 16 to 17 percent.

Silicon, the basic material used in solar cells, is quite plentiful. The technology has a sound base of experience as a result of the many solar devices produced for spacecraft that have been successfully orbited.

Solar cells today are relatively expensive, but the key to a drastic reduction in their cost is high-quantity production. A single solar power satellite will require many times the amount of solar cells that have been produced for all previous solar cell applications combined. This tremendous boost in production is expected to drop the cost of a solar cell to one-fiftieth of today's cost.

Microwave transmission in Space does not require the use of a vacuum-tube type of amplifier such as a *klystron,* since Space itself is a vacuum. Instead, we can use a more efficient device, the *amplitron,* to transmit the microwave energy. Such devices have demonstrated very high efficiency, reliability, and long life, and are extremely lightweight.

In terms of efficiency, the entire transmission chain-from the distribution of power to the space-borne microwave antenna, to the beaming of MW energy to Earth, and finally to the conversion of the microwave to DC power-is expected to achieve a level of better than 65 percent. Recent tests at NASA's Goldstone, California, facility have confirmed the microwave link's efficiency.

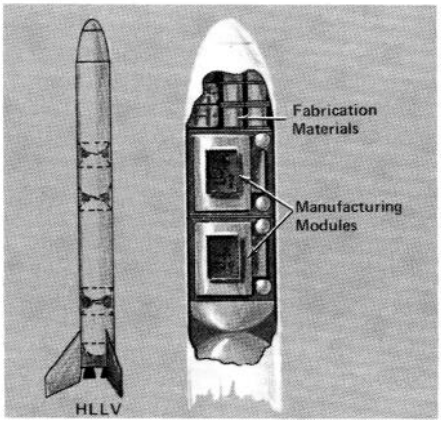
While the theoretical efficiency of the solar-to-electric power transfer between Space and Earth appears to meet the requirements, there is still the matter of determining the best way to get this huge satellite solar power station into orbit.

In terms of mass alone the task is staggering -- a 5,000-megawatt SSPS might weigh as much as 40 million pounds. But there have been developed a number of ways in which this might reasonably be accomplished. One promising method involves a system whose principal stages are shown on pages 8-9.

The Space Shuttle, slated to become operational in the early 1980s. offers the basis for beginning the total space solar power enterprise with certain key experiments and also provides a means for transporting elements of a Solar Power Development Lab into orbit.

Of course, the Shuttle Orbiter's payload (65,000 lb) and cargo bay volume were not designed for transporting so large a mass into Space. Were the satellite structure built -- primarily of truss-work -- on the ground and put into the Orbiter's bay, there would be much wasted space. An alternative is to build the structure in Space and to use another payload vehicle with a larger, more efficient, cargo capacity. Such a vehicle might take the form of a large cylindrical can with a payload of 160,000 lb which would replace the piggy-back Orbiter on the Space Shuttle.

Looking further ahead to the need for transporting SSPS elements in meaningful quantity within a reasonable build-up schedule, plans are made for a Heavy Lift Launch Vehicle (H.L.L.V.) that can carry 400,000 lb in a single launch into a near-Earth orbit.



Once the mass of basic construction material is brought by the H.L.L.V. into low Earth orbit (below, and therefore unaffected by, the Van Allen Radiation Belts), manufacturing of the SSPS structure can be started in Space.

By using spools of material, either aluminum or composite strip, small structural elements would be made in the form of triangular cross-sections and then built up into complete beams. Continuing this process, all the structure needed could be produced.

In general, manufacturing the SSPS in Space would require little human power. Work vehicles fitted with articulated manipulators, operating from space stations also used to house a small work crew, could assemble the entire satellite structure.

Once the huge structure is assembled, the next step is to move it from low Earth orbit to the high, or synchronous, orbit. To do this will mean traversing the Van Allen Belts whose intense radiation could seriously damage the exposed solar cells. The idea for avoiding this exposure is to mount the solar cells on blankets of material that are rolled up like window shades during the orbit-changing phase, thereby shielding them from the radiation. Once the SSPS attains the desired orbit, the blankets of solar cells would be rolled out and available to receive the Sun's energy.

The abundant solar energy in Space should be further used to move the SSPS into its high orbit. The design calls for a Solar Electric Propulsion System, or SEPS, in which the Sun's energy is used to drive an ion engine. Applying a low-level but continuous acceleration, the SEPS would propel the entire satellite solar power station up to synchronous orbit.

There, an attitude-control system comprised of jet thrusters similar to the ones used on our Lunar Module, would be used to nudge the huge satellite into its operating position, with antenna pointed toward the Earth-based rectenna and solar arrays broadside to the Sun. Because the satellite's orbital path will be affected by various forces in Space -- including gravity gradient, solar pressure, the interactive pull of the Sun and Moon, and motion due to the Earth's ellipticity -- it will require periodic adjustments to keep its proper station and orientation with respect to the rectenna. Estimates are that about 100,000 lbs of fuel per year would be sufficient to keep the SSPS in proper position.

Some human maintenance of the space facility will be required, but it is expected to be minimal over the projected 30-year life of the system. While it is quite clear that placing an SSPS in orbit would be a great undertaking, it would result in the continuous delivery, over a 30-year period, of 5000 MW of power-roughly enough to power a city the size of New York. The design in fact calls for putting up enough stations in orbit to meet 10 percent of the annual incremental electric power requirements of the U.S.

Despite its enormous scale, complexity, and technological challenges, the SSPS provides a great many advantages. Among these are: rapid pay-back (estimated at two years) of the net cost of the energy to build the system; delivery of environmentally "clean" power into the regular power grid; and production of a significant volume of power (one SSPS would provide the equivalent of 200,000 barrels of oil per day or, over a 30-year period, $36 billion worth of electricity).

INTERVIEW WITH PETER GLASER

Carolyn Henson

Peter Glaser is a Vice President of Arthur D. Little, Inc., and the originator of the solar power satellite (SPS) Concept.

I'd like to know what's happening with the Grumman study on space industrialization.

The space station study which Grumman Aerospace and myself have been carrying out on behalf of Marshall Space Flight Center has looked very hard at the kinds of problems one might encounter in constructing the satellite solar power station in orbit. It has included considerations of construction bases. Also, attention is being paid to space processing -- what can one do in space which would be of real interest.

I've read some interesting things about vapor deposition of silicon solar power cells. Is that being considered as a possibility?

This possibility is an example of such kinds of processes. Whether or not a specific one would be the way to go is probably too early to tell, because, as far as I understand, studies of this particular approach are still in the very early stages of investigation.

How many people does the Grumman study estimate will be needed on site to assemble a power satellite?

I really don't have the number. Remember, the first steps are not really to make the whole satellite but rather to make the first small-scale test object, which may be just a few hundred kilowatts or a few megawatts. And the question is, how would you go about assembling these small test objects, learn from them, and then apply the learning to the bigger ones? So it's really hard to go from where we are today to a full scale satellite without a lot of learning on the way.

So you are planning an evolutionary approach, then?

I think it is the reasonable approach, because there are some very tough problems. It isn't just a matter of assembly, but what kinds of components you would be willing to produce in space and, as you know, there are studies along these lines. Can we produce girders and other structural components to be used to produce satellites from rolled aluminum coils? I think these are of great interest.

Another one is: should we attempt to, for example, produce silicon solar cells in a space station or construction base, or should we carry the material from Earth? All of these involve not just technology but a lot of economics.

There have been studies on the use of lunar resources to produce oxygen to propel solar power satellites from low Earth orbit to geosynchronous orbit Is your study group considering the use of luner materials?

Our study is much too near term for those considerations. You really have to learn to crawl before you can walk.

You're basically concentrating on assembly, then?

At this moment it is too early to consider whether you'd like to use lunar materials. I'm sure that will be a very important topic, however, once we've done some of this earlier work.

Are you familiar with the solar power satellite proposals of James E. and Ronald N. Drummond? (see L-5 News, August, 1976, p. 8.)

I believe they certainly are interesting and should be studied further. The particular Sun-synchronous orbit certainly has some advantages, although it does involve a much shorter time for the microwave beam to reach receiving antennas. The multiplexing that could be involved may introduce some additional complexity.

Whether this is the right orbit or geosynchronous is the right orbit is a matter one will really have to understand and study-and I think this approach, especially his suggestion of using dielectric power conversion, indicates that the more people start to think about satellite solar power, we can look forward to novel ideas, and out of that eventually will come what I hope is the optimum solution.

It's only by doing the work and trying various approaches we will develop the optimum solution.

WIRELESS POWER-TRANSMISSION TEST AIMS AT HARNESSING SUN

John F. Mason, reprinted with permission from Electronic Design, Dec. 6. 1975.

For 75 years, engineers have tried to transmit power through the air without benefit of wires or other man-made conduits. Now a group of engineers in the in the Mojave Desert are doing it every few weeks via microwave signals.

They are from the California Institute of Technology's Jet Propulsion Laboratory, in Pasadena, and Raytheon's Microwave and Power Tube Division, Waltham, Massachusetts. Their work is being sponsored by the National Aeronautics and Space Administration's Office of Applications and Office of Energy Programs.

The distance covered and the power transmitted in the Mojave experiments are both small (a little over 30 kW. of d.c. output over 1.54 km.), but the techniques for improving both are being defined.

The ultimate goal is to develop equipment capable of efficiently transmitting power captured by a solar-energy collector in space to a receiving station on earth. Such a proposal was first made in 1968 by a team consisting of Arthur D. Little, Raytheon, Grumman and Textron.

A more earthly application might be to beam power to a high-altitude, stationary, electrically powered, unpiloted helicopter -- say, at 50,000 feet -- that would relay television signals for weeks or months at a time without having to land.

Point-to-point transmissions on Earth are, of course, possible applications, but highly improbably, according to Raytheon's consulting scientist William C. Brown, who developed the rectifying antennas used in the current experiments.

"The attenuation and scattering through many miles of rain would be a problem," he says. "To replace high-power transmission lines, the power density in the beam would be far above safe exposure limits. The economics might also be questioned."

There could be isolated applications, Brown continues, that might be practical -for example, where power could be profitably transmitted over deep canyons or bodies of water. But the main goal is to capture clean, nonpolluting energy from the Sun. Earth-orbiting stations would collect solar energy, convert it to microwave radiation and beam it to receiving stations on Earth.

"A typical satellite using a microwave beam at a 10-cm. wavelength could provide 10,000 MW.," says Peter E. Glaser, vice president of Arthur D. Little, Inc., Cambridge, Massachusetts. "A network of such satellites could generate enough power to meet a significant portion of the foreseeable U.S. energy demands."

The space station would require an energy-collecting area of at least 70 Sq. km. of solar photovoltaic cells, according to Raytheon's Brown. "The area needed for ground-based 'rectenna' arrays, as the antenna elements are called, measures some 40 to 59 km.," he says.

The immediate goal of the current experiments is to test the high-power performance of a reception-conversion array rather than an over-all system. Existing transmitting equipment is being used, consisting of a klystron with a maximum output of 450 kW. at 2.388 GHz., a 26-m. diameter (85 ft.) parabolic reflector antenna, and a 30.5-m. tall (100 ft.) collimation tower located approximately 1.54 km. (1 mile) from the antenna. The equipment is part of the Venus station, a research and development facility of NASA's Deep Space Network at Goldstone near Barstow, California.

Thus far the Mojave Desert tests have shown, JPL says, that the present rectenna array concept should be adequate for a somewhat weather-dependent, yet highly efficient, receiving mechanization for a high-power microwave power transmission link. To improve the system, a number of innovations are needed, JPL says: diodes with higher conversion-efficiency, a better array impedance match and simplified techniques for mass manufacturing and assembly.

Collecting the Power

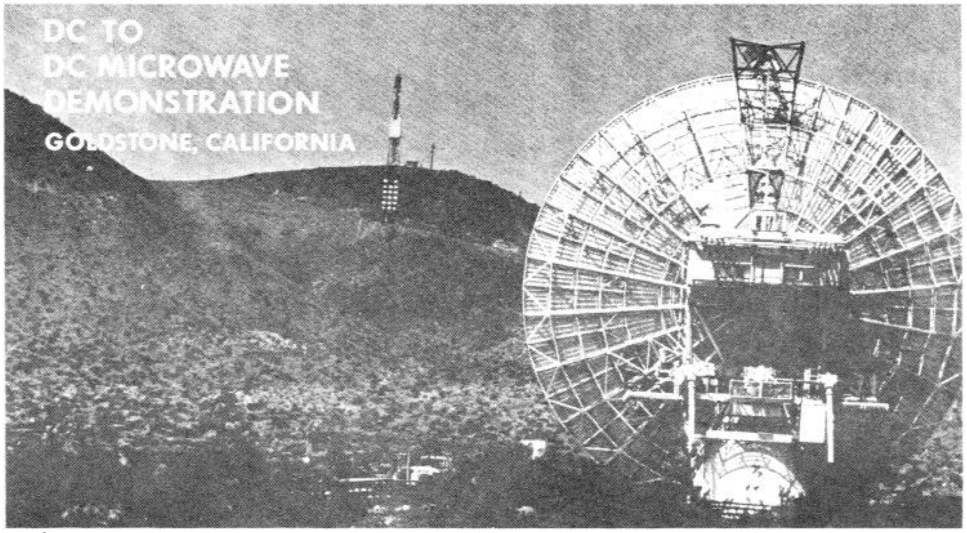
The transmission of power via microwave differs from transmission of communication signals, in that a greater percentage of the power must be received. You can amplify weak communication signals but not power.

In the space station, a series of microwave generators would be combined in a subarray about 15 meters square, and the latter would form part of the transmitting antenna, adcording to Peter E. Glaser.

The generator design, Glaser says, is based on use of a crossed-field device such as an Amplitron, which has the potential of high efficiency, high reliability and very long life. Each generator subarray must be provided with an automatic phasing system, so that the individual radiating elements of the antenna are in phase. These subarrays would be assembled into a slotted-waveguide phased-array transmitting antenna, about one km. in diameter, to obtain a microwave beam. The distribution within the beam could be designed to range from uniform to Gaussian.

In the ground experiment microwave power is being received and rectified with a Schottky barrier diode detector. However, the diode operates at a power level of +39 dBm., and the output is d.c. Although other power output forms, such as pulsating d.c. or even low-frequency a.c. (60 Hz.), can be obtained,

POWER TRANSMISSION SYSTEM



- TRANSMITTER DIAMETER - 26 m
- MICROWAVE FREQUENCY - 2388 MHz
- RANGE (TRANSMITTER TO RECEIVER) - 1.5 km
- SYSTEM EFFICIENCY - 82.5%

d.c. was selected for system simplicity at this time.

The function of the receiving system is to collect the incident RF and convert it to d.c. This is done by building the receiving antenna in the form of a planar array of half-wave dipole rectenna elements over a ground plane facing the transmitter incident beam. Each dipole has an integral low-pass filter, diode rectifier and RF-bypass capacitor.

The dipoles are d.c.-insulated from the ground plane and appear as RF absorbers in parallel to the incoming RF wave. Their d.c. outputs are in a parallel and series combination to produce the desired output voltage and current levels.

The size of the dipoles and their configurations are adjusted so that when they are in combination with the transformed d.c. load impedance the array provides a match for the incoming RF wave. The dipoles are 0.74 h long; they are spaced 0.6 h apart in a triangular lattice and are 0.2 h from a ground plane.

The low-pass filter design represents a compromise between insertion loss at the fundamental and the proper rejection at the harmonics. The harmonics must be trapped and phased properly to result in maximum RF-to-d.c. conversion (inverse Fourier Transform).

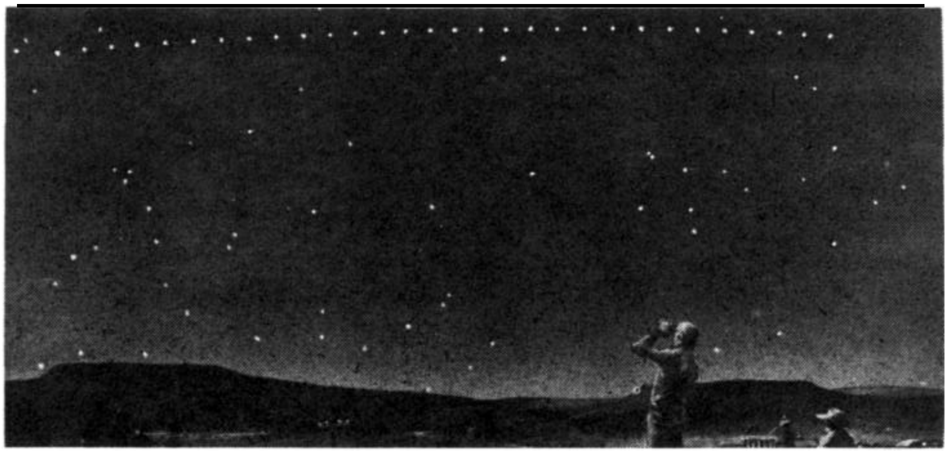
The RF-bypass capacitor in the rectenna performs the dual function of a smoothing filter for removing RF and harmonic ripple from the d.c. output and resonating the diode capacitance so that the proper impedance match between the diode and the low-pass filter is obtained.

Collection efficiency approaching 90 per cent in the 3-GHz. region is expected ultimately for the rectenna, Brown says. The present efficiency of the rectennas at Goldstone is 82 per cent. A principal reason for this optimism is the very high potential rectification efficiency of the GaAs Schottky barrier diode when its depletion layer is optimally designed for this application and when rectifier circuits using such improved diodes are also optimally designed.

The physical capture area of the array, including the interstices between subarrays, is 24.5 m^2 (263.5 $ft.^2$). Each of the seventeen subarrays is positioned normal to the beam from the Venus station antenna. All subarrays lie in the same plane. The seventeen separate d.c. load and instrumentation wires from each subarray are routed to a central load and instrumentation complex, located in and near the collimation tower support building.

Additional tests of the ground system are planned to determine performance vs. frequency, incident polarization, treatment of the interstices and the effects of various environmental conditions, including rain, snow and angle-of-incidence variations.

SOMETHING NEW IN THE STELLAR LINEUP



Strung across the sky like a string of pearls, thirty power satellites in geosynchronous orbit could be added to the stellar scene if a BAC study should lead to building of the space-based power units

BOEING GIVEN CONTRACT FOR STUDY OF SPACE-BASED SOLAR POWER

Bill Rice, Boeing News

A study of space-based solar power concepts designed to determine which may be worthy of further technology studies and, possibly, systems demonstration, has been assigned to Boeing Aerospace Company by the National Aeronautics and Space Administration.

The contract, awarded by NASA's Johnson Space Center and valued at approximately $970,000, is in two study phases. The first, of five months duration, will address itself to the selection of viable solar energy conversion candidates and to the location of their construction in space.

The second phase, to run seven months, will be aimed at refining cost estimates and at the reduction of satellite mass.

Over the past several years, Boeing and other aerospace firms have developed a number of concepts for the gathering of the Sun's energy in space and for the beaming of this energy to Earth for use here as electricity. These concepts include:

-The orbiting of a series of huge reflectors measuring miles in length and width which would reflect the Sun's rays into central furnaces, or solar cavities. These furnaces would heat gases which, in turn, would drive generators which produce electricity.

-The orbiting of huge fields of solar cells-again measured in miles-which would transform solar rays into electricity.

Equal to Coulee Dam

In both concepts -- and there are several candidates proposed for each approach -- the satellites would beam the electrical power to Earth as microwaves which would be received by large antenna arrays. The microwaves would be reconverted to electrical energy and fed into the nation's power system. These satellites each would have the capacity to produce power on the order of that produced by Grand Coulee Dam or several nuclear plants.

The power satellites would be stationed in geosynchronous orbit some 23,000 miles (37,000 kilometers) above the Earth. At this height, the satellite, as viewed from the ground, would appear stationary.

Weighing thousands of tons and covering many square miles in area, these satellites will be too massive to be constructed on Earth and launched into orbit. Boeing, under its new contract, will attempt to determine whether it will be better to assemble these large space structures in low Earth orbit and then transfer them to geosynchronous orbit or whether it would be better to assemble them in geosynchronous orbit.

The study is part of a systematic NASA investigation into the feasibility of the solar power satellite concept and of those systems needed to support it.

Nondepletable Source

The overall concept offers the hope of tapping an alternate energy source which, unlike fossil fuels and nuclear fission, is nondepletable. However, for it to be viable, it must be capable of producing large amounts of energy at a price competitive with other energy sources.

In addition to the Johnson solar power satellite concept, Boeing presently is conducting power-satellite-related studies in the areas of:

-Low-Earth-orbit transportation of a sort which would carry massive amounts of material into space at low cost.

-Orbital transfer systems which would be used to ferry men and material into space at low cost.

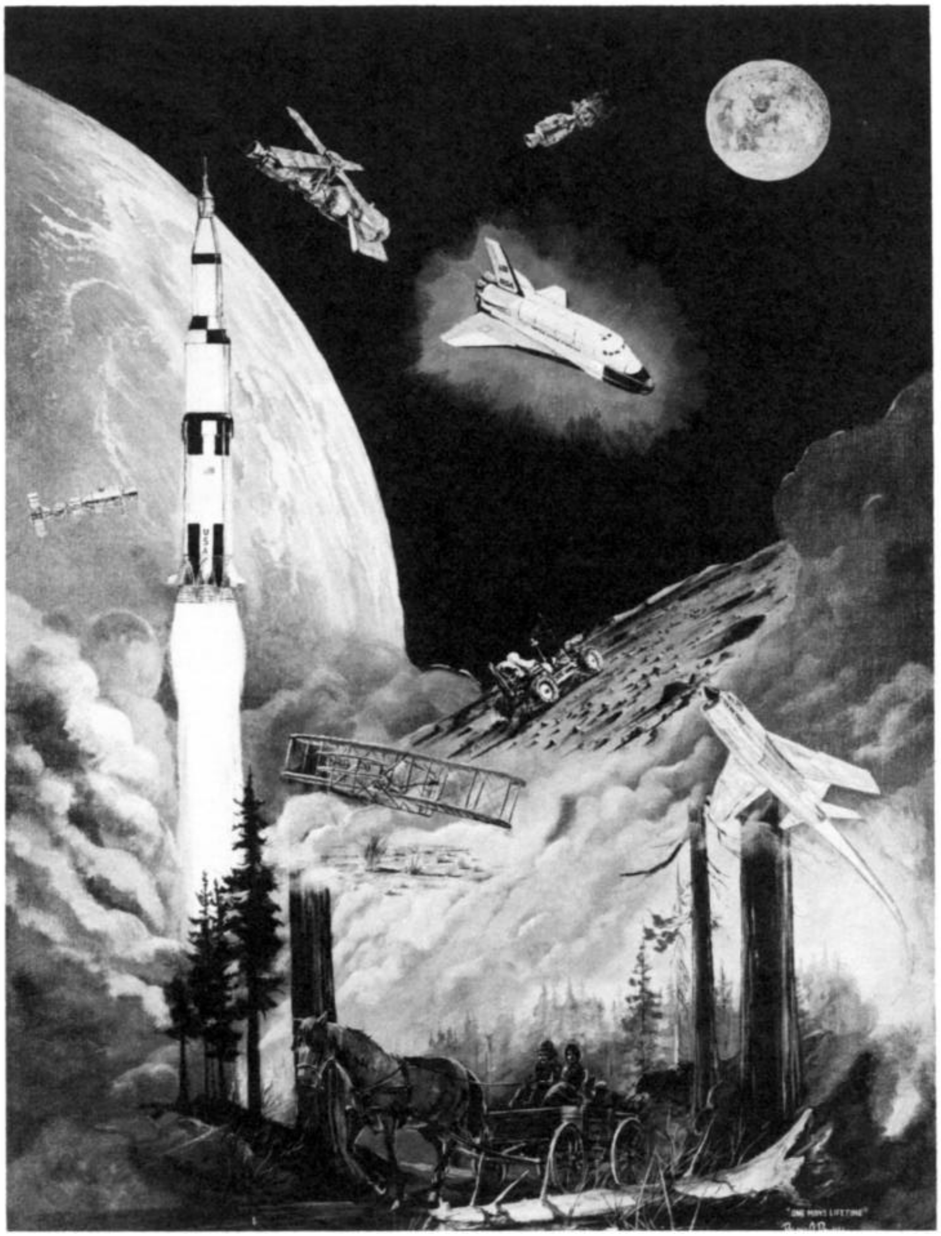
-Fabrication and assembly of large space structures.

-Development of advanced-technology solar cells.

MOVEMENT INTO SPACE: A VIEW FROM

Part 1 of Interviews with Dr. Timothy Leary and Captain Robert Freitag

Elizabeth Robinson



In October 1976, the well-known consciousness proponent of the 1960's, Dr. Timothy Leary, and Captain Robert F. Freitag, Deputy Director, Advanced Programs, National Aeronautics and Space Administration (NASA), presented their views in separate interviews, on the movement into space-by citizens, free enterprise and government.

These interviews addressed several aspects of the movement into space: (1) space migration and evolutionary philosophy; (2) citizens' space migration; (3) the urgency of space migration; (4) the concept of cooperation and control in space; and (5) the effects of space migration on the future of humanity. Part I of these interviews will focus on the philosophy of the space movement and citizens' participation in it.

Dr. Leary was released from prison in the spring of 1976. A Harvard psychology professor who engaged in early experimentation with the effects of "psychedelic" drugs, Dr. Leary found himself a popular leader of the consciousness movement in the sixties. To some, he was a hero; to others, a threat. He became ward of the prison when a half ounce of marijuana was found in his car as he crossed the border from Mexico to the United States. With another relatively minor drug charge, Leary spent several years in prison. While there, he developed an interest in space.

Since his release, Dr. Leary has been lecturing around the country to thousands of college students and other audiences about his threefold cause -- "S.M.I.^{2}L.E." "S.M.I.^{2}L.E." is an acronym for Space Migration, Intelligence Increase, and Lifespan Extension.

Evolution and Space Migration

"The movement from Earth to Space. . . is a genetic imperative . . . "

Tucked away from the crowds he had come to address in Washington, D.C., Dr. Leary settled into a chair and began to explain his concept of space migration.

I have no concept of it [of my own]. The work of O'Neill and the Ames conferences, the L5 Society, and the anthropologists and the sociologists who have been working on these matters are very convincing to me. . . I'm simply broadcasting their messages.

In your lectures, you have linked new frontiers with new ideas and new philosophies Would you elaborate on your concept of migration in terms of change?

I believe it to be the destiny of the human species and of planetary life itself to migrate-that we're not terrestrial, we are predestined to leave the womb planet and to move through post-terrestrial space.

Do you believe, as one person wrote, we either "grow or die"?

Yes. Not grow in size, but grow in intelligence, speed and precision.

What do you see as the relationship between human evolution and space migration?

They are completely intertwined. It is our evolution or destiny to migrate from the planet as it was our destiny to leave the water and become amphibian, and then later land creatures. I believe the sequence from sea to shoreline to land to air to space is built into our DNA blueprint.

Do you see a relationship between how we view the future, space migration, and our image of ourselves as people?

Yes, after reading the scientific papers about space migration, I became convinced that we are not basically terrestrial, that we are seeded and spend our immature larval state within the embryonic confines of a planet. But when we can attain the escape velocity to evolve, we will leave the nursery planet, and find our adult evolutionary status as mobile entities within the solar system, and eventually within the galaxy.

You have also called this movement into space a "birth into the universe. " Do you think this "birth" will inspire the creation of another cosmic myth, similar to those of the ancient Greeks and Romans?

TWO WORLDS

Yes, I think of the fact that we are not designed to spend all of our years on the earth-our now-larval creature is ready to mutate. It's more than a. myth-it's a genetic reality. The myths of Homer and Virgil are simply terrestrial migratory myths celebrating the movement from the east to the west, along the Mediterranean and across the Atlantic, but the movement from earth to space is like the movement from water to land. It's a genetic imperative.

Captain Freitag was asked to comment on the belief held by Dr. Leary and others that the movement into space is the next step for humanity's evolution.

I believe it's *an* alternative, not necessarily *the* alternative. I think, as I mentioned earlier, that the oceans offer tremendous possibilities and habitats under the ocean, for mining or for industry, which means removing some of the objectionable parts of our society from land and putting them under the oceans.

Later in the interview, Captain Freitag went in to greater de tail on the philosophical basis of the space movement. He brought out a paper from his desk.

I spent some time writing this several years ago; it's a quote from a talk I gave:

> "Turning for a moment to philosophy, I see two very striking facts about our world of today. One is the explosive growth of the world's population of the twentieth century, and the other is the advent of space exploration. I feel intensely that these two events do not coincide by accident. Some inner motivations are leading humanity to new and unknown shores. Therefore, we are gathering our strength and reorganizing our social structures.
>
> "As I mentioned, life is a force which has persisted on earth for three billion years, and it's spread across this planet like a grassfire . . but three billion years it took it to spread. It's gone out to touch the moon, and it's now touching the other points of the galaxy. This life will survive for many millions of years more, and it will continue to expand and to weave its way out into the Cosmos.
>
> "Almost instinctively, humanity will follow this push, and settle on other planets. I believe that's going to happen. Thus, our population explosion may not be a bizarre mistake of nature at ail, as some claim. It may be just preparation for space travel which is part of our destiny because the solar system could not be conquered by a mere three billion beings."

So I agree with what he [Dr. Leary] is saying. I disagree violently with this time scale . . . that it's a *now* thing. It is not a *now* thing. I go on to say:

> "We are convinced beyond doubt that humanity will colonize the planets. When we will start this-whether it be 1984, 2001, or a couple of centuries later. and whether it be done by the United States, or the Soviets, or a joint project involving all the nations in the world-I don't know. But I am profoundly sure that humanity will go on these voyages."

Now, I believe in what he's saying -- eventually. What I'm trying to get across is that too many people today are trying to make this something that's happening now. I don't mean to be a footdragger, but it's just got to take time.

Is this strictly a personal view you have expressed concerning the philosophy of moving into space?

No, I think parts of it are definitely shared by NASA. The colonization of the planets is probably something that we do see. But let me say that a view not too far from the one I expressed is shared by a great number of people in NASA, particularly the people in the planning area. I think it's significant that we (i.e., NASA) don't disagree with what was in that quote. . . just how you go about doing it and what is done.

The Consciousness Movement of the Sixties and the Space Movement of the Seventies

"You cannot create anything externally which you have not experienced internally."

Dr. Leary, most people know you in terms of what you did in the six ties and the consciousness movement. Would you explain the relationship between the consciousness movement of the six ties and the movement into space?

I see human events as being genetically predetermined. It was inevitable that the first generation of young people after Hiroshima would develop a consciousness movement which would allow them to detach their bodies and their nervous systems from the blind robot direction of the Human Ant Hill. It was inevitable that the second generation after Hiroshima would use the expanded and liberated consciousness of of the preceeding generation to create an externalization of the internal vision which the consciousness movement produced.

What made it inevitable that the consciousness movement develop after Hiroshima and Nagasaki?

The terrestrial ballgame was over with Hiroshima. There could be no more territorial warfare; no more imperial conflict; no more technological competition on the planet. We had outgrown the planet with Alamagordo.

In order to leave the planet, we have to detach our nervous systems and get control of our own bodies, and essentially, to mutate beyond the Hive of Domestication that characterized our species before 1960.

Since 1960, almost every American has been somewhat involved in some form of rebirth or consciousness experience. The Gallup poll recently demonstrated that over half of all Protestants have had rebirth experiences, which are watered-down versions of the consciousness movement of the 1960's.

What makes it inevitable for the second step to occur (i.e., space migration)?

Once human beings have become detached from their commitment to insectoid or hive directions and search within their own neurology, the visions which emerge inevitably point to the post-territorial destiny of our species. But post-territorial visions could not be tolerated before humanity had attained the technological sophistication which was demonstrated in the nuclear fission experiments.

I believe that these sequences of technology-both inner and outer-are quite routine and standard on all biological planets. There's nothing that unique about the human species, nor about our planetary development here on Earth.

So the inner consciousness movement was just the preliminary step to the movement in to space?

Yes. You cannot create anything externally which you have not experienced internally. Everything that humanity had done externally with our machines, with our technology, with our material structures, have always been preceeded by a neurological or inner visionary revelation.

To illustrate this point, I cite the case of Albert Einstein, who, we are told, continually attempted to imagine or to experience, what it would be like to be a photon . . . that is, to be traveling at the speed of light. Once he could (through self-hypnosis) coax his nervous system to operate in speed-of-light terms, it was obviously a simple matter for him to understand and then write the equations which have so revolutionized our physics.

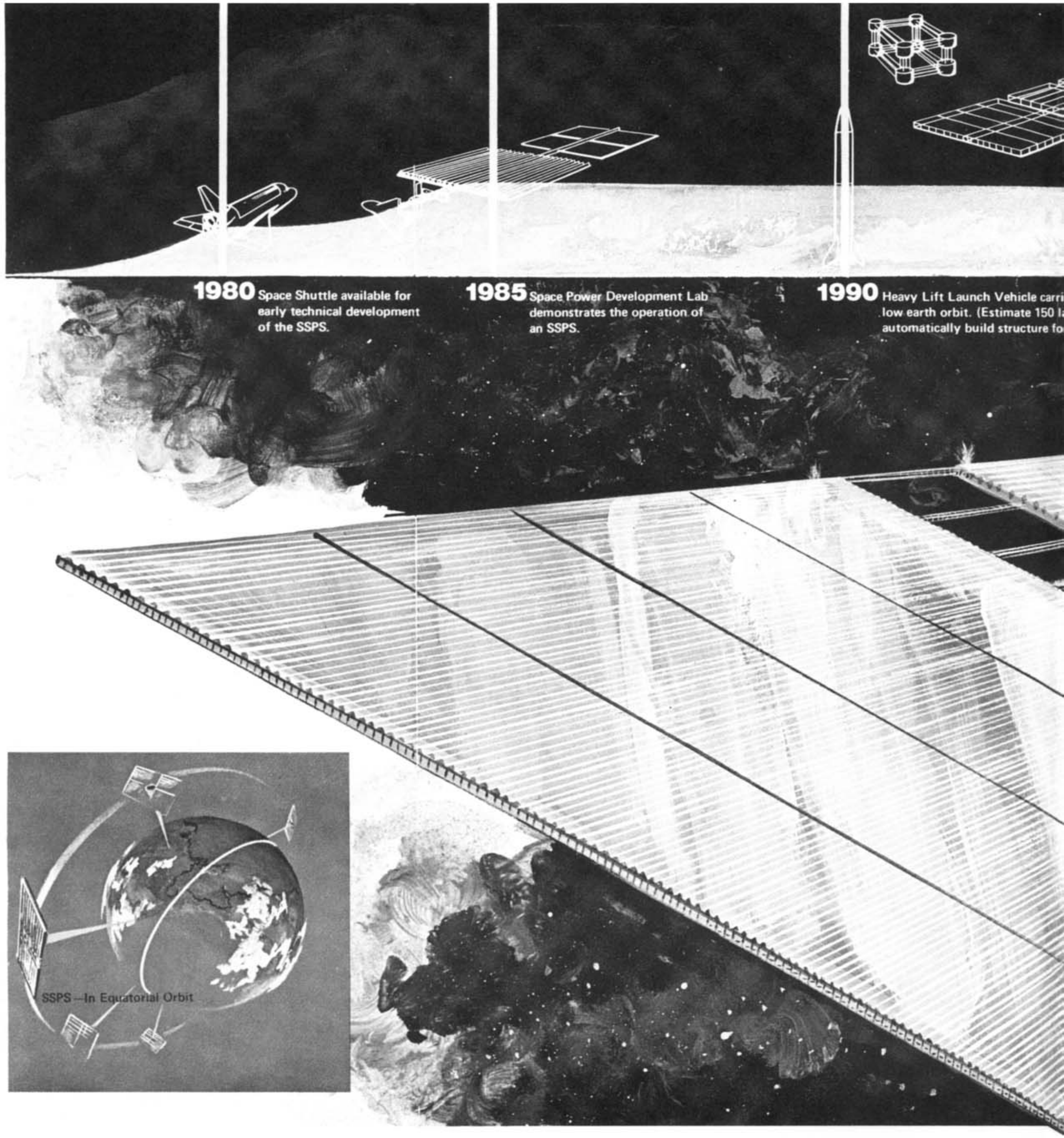
The Einstein story makes the point that physics, chemistry, and engineering should be experienced-and usually have to be experienced-before the equations are written. Physics and engineering without the experiential is a depersonalized and inhuman enterprise.

And there are other scientists who have had such experiences?

Well, I don't know. I think there are never more than a handful -- five or ten -- scientists alive at any one time in human history. The rest are engineers or reproducers. I suppose that every scientist has had to have some way of turning on his nervous system to experience what he was thinking about. Certainly, Darwin did this in his epic-making voyages to the Pacific.

Captain Freitag of NASA was asked if he saw any connection between the consciousness movement of the six ties and the present space migration movement. He commented:

Absolutely no connection whatsoever. I think it was just timing. There may be some connection by inspection. Were space not available to them, if technology



1980 Space Shuttle available for early technical development of the SSPS.

1985 Space Power Development Lab demonstrates the operation of an SSPS.

1990 Heavy Lift Launch Vehicle carri
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SSPS—In Equatorial Orbit

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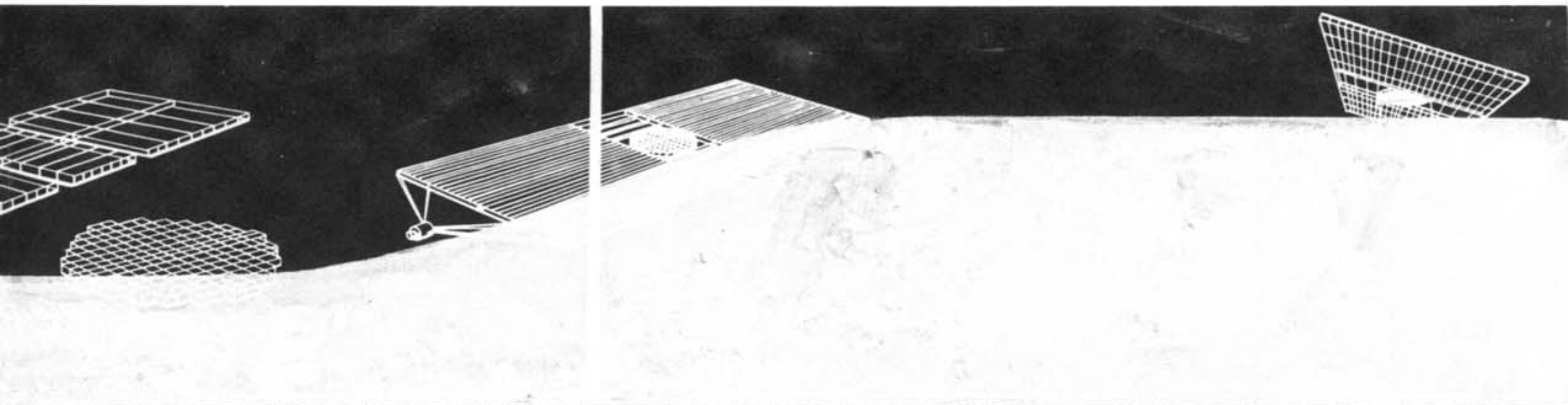
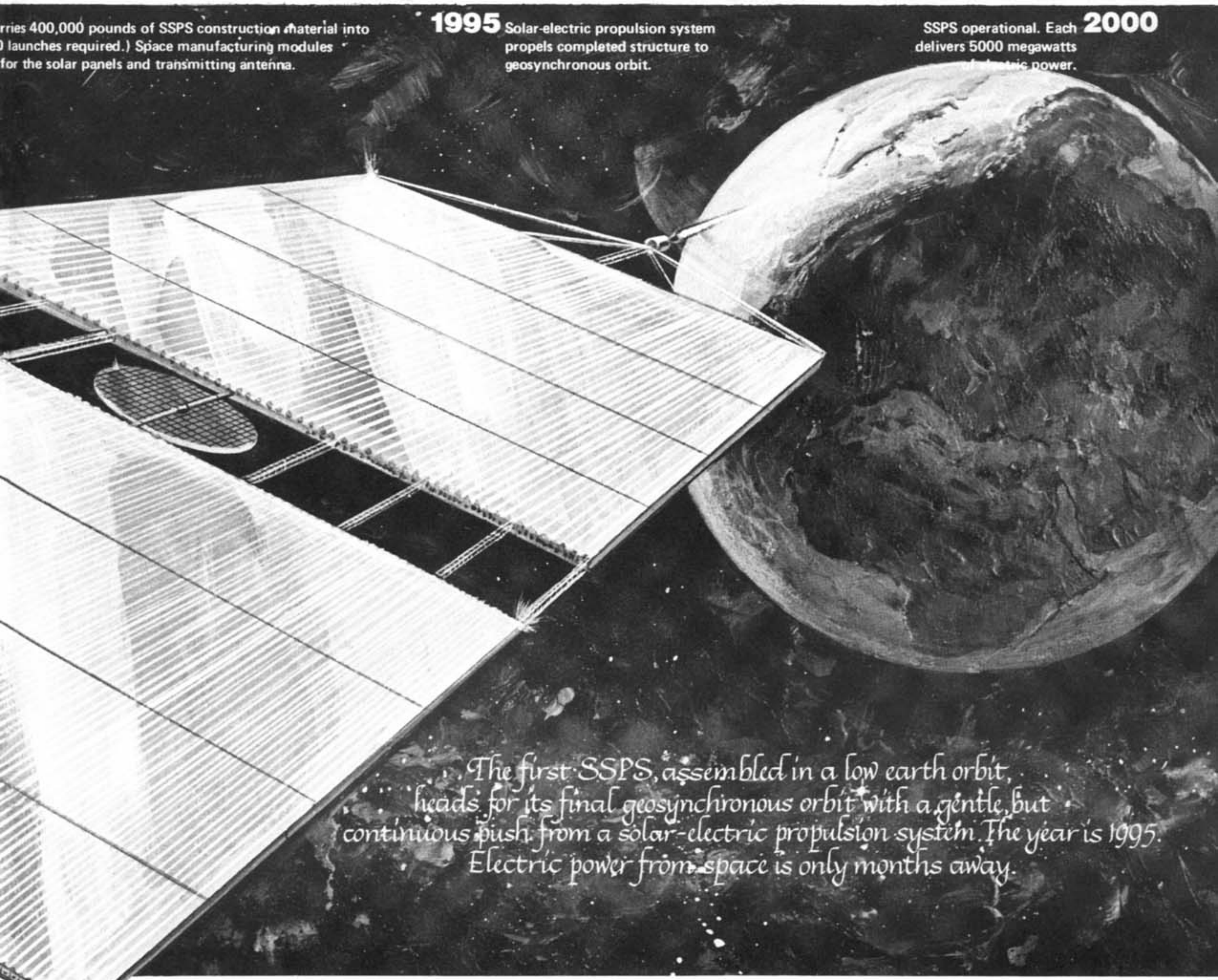




rries 400,000 pounds of SSPS construction material into
0 launches required.) Space manufacturing modules
for the solar panels and transmitting antenna.

1995 Solar-electric propulsion system propels completed structure to geosynchronous orbit.

SSPS operational. Each **2000** delivers 5000 megawatts of electric power.

The first SSPS, assembled in a low earth orbit, heads for its final geosynchronous orbit with a gentle, but continuous push from a solar-electric propulsion system. The year is 1995. Electric power from space is only months away.

ower Stations Timetable

(FROM GRUMMAN AEROSPACE HORIZONS)

had not demonstrated to the world that space was a viable place to go, that same movement would have found another outlet.

That outlet might have been migration to Timbuctu; it might have been migration under the oceans; it might have been an outlet in some other manifestation-music-or a thousand and one spiritual things. It might have been a great religious movement; it might have been something else -- anticommunism -- you can name anything you want.

Space happens to be an outlet. It happens to be a very pleasant outlet; it has many desirable features; and it is happening. So I think it is a coincidence. That coincidence-again-may be something that some great planner above has gone beyond and laid out.

There would have been another outlet if it had not been space. If we had killed the first man in orbit in the sixties, and killed the second man in orbit, this program would be dead, we would know without any doubt that it's impossible to go into space.

Grassroots in Outer Space

Dr. Leary, what is the virtue of establishing a colony? Who wants to go to a colony?

Well, it's like a butterfly . . . a caterpillar becoming a butterfly and learning how to fly . . . like a bird in the nest just getting ready to flap its wings and soar out over the air. Nothing is more exciting than to be in a position where you are just about to live out your predetermined destiny.

Do you think there should be a citizens' space migration movement?

I think that there should be many such movements. I think that every group of people who share any sort of communal vision which they want to externalize should band together; raise the money; and generate the energy to set up their own space habitat.

The Mormons should do it; the Catholics should do it; the vegetarians should do it. It's not just one big citizens' group.

Diversity -- just as the Plymouth mothers and fathers joined together to build their Mayflower -- exactly *that model* should be used. There should be no reliance on big government or big industry or big citizens' groups.

We should encourage diversity. We should get the Salvation Army; the ladies' softball league; the Sierra Club; and the National Rifle Association-let them have their own space cylinder. That's fantastic. I'm all for it.

What to Do for an Encore?

According to Dr. Leary and others involved in the space movement, there seems to be tremendous growth in the public's interest in space. Captain Freitag, do you have a similar impression?

I don't accept that as what's really happening . . . we're seeing a *resurgence.* You recall the interest in space in 1967, '68, and '69, which was extremely broad. We're just beginning to get back up to a small percentage of the interest that we had in the country at that time. What happened in my opinion, is that after the lunar landing, we found ourselves in the position of "What are you going to do for an encore?" People lost interest.

In the first place, we wound down the space program to something far less dramatic. There will never be anything in our lifetime as dramatic as putting a man on the moon-that's a once-in-an-epoch flight.

You can land on Mars, or you can land on another planet. But it will never compare to the threshold we stepped over when we landed on the Moon. That's the first time humanity left this planet.

At that time, we also had three or four things going on. We had a very great upswing in Viet Nam; it totally preoccupied the nation's interest. As far as government was concerned, we were pumping $40 billion a year into Viet Nam. You couldn't put large amounts of money into space, spending that kind of money.

At long last, we started paying the price of inflation, which came about at that point in time. The civil rights problems, the assassination of Dr. King, and the campus riots took the interest away from space.

Meanwhile, there was nothing really going on in space, because we had made a very conscious decision to phase out the Apollo program and move into the Space Shuttle which would take a decade to bring into being. In that period, there was only extremely minor activity going on . . . minor new activity. There was a great expansion of the continuing activity -spreading communications throughout the world and so forth. So now, we're beginning to understand what this new capability of space is. We see a resurgence of interest in it.

Space and the Oceans

Captain Freitag:

It's a strange thing-we started off this conversation talking about the popularity of space. All during the period of the Apollo program, we kept track of polls, typically run by Congressmen, on how popular the space program is. If you average all the polls taken during that decade when we were reaching for the moon, you seem to find that roughly 65% of the people wanted to go into space. That's two out of three people who think that space is good.

There were times, like after the Apollo fire, when maybe it was 15%; there were times, like after the lunar landing, when it was nearly 100%.

In that same period, you take polls like "let's build cities under the ocean." Why isn't there a great migration to go under the oceans just like Leary says we want to go into space? It turns out that only about 10 or 15% even want to explore the ocean, let alone build habitats under the sea to mine those great resources. They don't want to do it.

So two-thirds of the people think space is great, just like they thought aviation was great in the last fifty years. So, I think, with that motivation, people *will* move out into space. But it will not be a grassroots migration; it will be a very logical, step-by-step process. I don't want to say controlled. It will be highly voluntary and highly supportive, it will be highly disciplined and highly organized, because that is the only way that you could ever survive in space.

What do you think NASA and the U.S. government should be doing as far as space colonization and industrialization is concerned, Dr. Leary?

I'm not that concerned with NASA and the United States government. Everything they do is fine. NASA is simply a bureaucratic agency serving the American people. And, the government -- shocking as this may sound -- is simply a servant of the American people. So, I think it's a citizens' situation . . . it's a free enterprise situation . . . it's a mainstreet, grassroots situation.

Far from worshipping and being subservient to NASA and the government, I think it's for them to listen to us; we'll tell them what to do. We'll tell them what we want. Neither the government bureaucracy or NASA has had that foresight in the past. It's up to us to tell them; they are our servants and our employees.

Hanging Out in Space

Captain Freitag, do you believe that a citizens' grassroots movement in to space, privately funded, is a possibility?

I think it's got to be institutionalized, and I use that term again on the basis that in order just to exist in space, it's such a tremendous effort . . . billions and billions of dollars. . . It's many, many times anything this world has ever tried to do-not only us (the United States), but everyone else. The program is hundreds of times the size of the Apollo program. You don't do this with grassroots movements.

If you can go out there and hang out by your fingernails like the colonists did at Massachusetts in 1620, where the natural environment allowed them to survive, then you have a chance for a grassroots movement. But you have to take all those things you are accustomed to here on Earth out to space with you -- and they've got to be there first.

I'm talking about just the simple things like heat, light, energy, and air, and the things that you take for granted here. By the time that is done, for every pound of people you take out, you take out hundreds of pounds of equipment to keep them alive.

If you don't have it done right, you will kill them psychologically almost immediately, cause there is nothing to do out there until you have this big activity there. To generate that from a grassroots financing point is like saying we're going to establish something comparable to the government of the United States on a purely voluntary basis.

Even the United States with all their resources can't do it by themselves. We don't know how to do it yet. How can a grassroots movement do it, if you haven't got those chances? Now, eventually, I think it will happen, but not until after the exploration has been done.

NASA's Catch 22

What do you think NASA and the government should do, Captain Freitag?

I think what we need to do is to establish a very broad research program, probably sponsored by NASA, in which we'd establish two, three, four hundred grants around the country to hundreds of universities examining all the problems associated with building a colony in space, with building a permanent habitat; and doing the basic research on what would be necessary to make that happen.

How do you develop advanced propulsion? How do you process lunar materials? Start this by training hundreds of people at college age level. By the time their careers mature in the next thirty to forty years, they and their students and their disciples will eventually have enough of a base, broadened throughout the entire country, to attack the problem of technology. I may sound like a pessimist, but I'm not. I'm an optimist. It's this office which is furnishing the money to keep O'Neill busy. We need that type of work.

But at the same time, we've just got to keep our feet on the ground, because if we go too far on out in the future, we lose our connection with pragmatic people who say "What have you done for me lately? . . . Have you done something that is economically profitable? Have you done something which is of sociological benefit to the millions of people on earth today, not to a small few in the future? Have you done something to lessen international tensions. . . or what?"

It isn't what you *could* do . . . it's what *have you* done.

Space is for the Birds

Dr. Leary was asked to comment on the politics involved in the movement in to space.

I think that most partisan politics is a primitive mammalian reaction involving control of territory and herd or tribe vertical dominance. I think that once the migration to space has been made, with the accessibility and unlimited access to space, territorial politics and partisan competitions for dominance will be tremendously minimized.

Bureaucrats want to control everything and limit everything to their own province. . . that's just one of the givens. We must not worry about failing. We are being forced off the planet just like birds are forced out of the nest. We can't fail . . . cannot make mistakes.

You see, migration from the old world to the new was inevitable. Certain people tried to control it; certain people tried to have monopolies; certain bureaucrats tried to limit it . . . sure. But nothing could stop it. Nothing could prevent the migration, and eventually, the independent liberation of the New World people.

I do feel space migration is an intelligence test of one's understanding of government. There's a naive assumption that space belongs to NASA, or that space belongs to the government in Washington. It doesn't: we, the people of the United States, have the final say on who will go to space and how we will go.

I'm not at all intimidated by bureaucrats in NASA, their fears, or their paranoia about my interest. I want to support NASA and government officials who are leading us into space; on the otherhand, I have no sense of intimidation.

NASA bureaucrats are *my* servants . . . and the servants of every taxpayer. If they act too paranoid, we'll fire them. If they act open-minded and creative, we'll promote them.

Moving Out into the Cosmos

"Life has reached out. . . and touched five planets."

*Captain Freitag, would you comment on Dr. Leary's statements that humanity is being forced off this planet and that nothing can prevent the migration of *'The New World people?"*

I can comment on that three ways. In the first place, he starts off by saying that we're being forced off the planet. I couldn't disagree more; we are not being forced off the planet. What he is talking about there is the "limits to growth" theory. I think that the limits to growth haven't even been explored. We're four billion people on this planet today, and I have perfect confidence that this planet can support 20 or 30 billion. I think we will solve that problem of population explosion by technology and by education long before we're forced off this planet. I disagree with any implication that there's a limit to growth and that we're being forced off the planet.

The second point, which is probably more significant, is the inevitability of exploration. It is no more inevitable than the inevitable migration to the South Pole or North Pole. Those two places have been on this planet since day one; they've been explored; they're rich in resources. But they are not habitable.

Now, technology can make them habitable-we have proven that. People have lived at the South Pole year round. But there's nobody beating the bushes to go to the South Pole; and there's nobody beating the bushes to go to a lot of the deserts and uninhabitable areas of this earth. No one is trying to live at the top of the Himalayas.

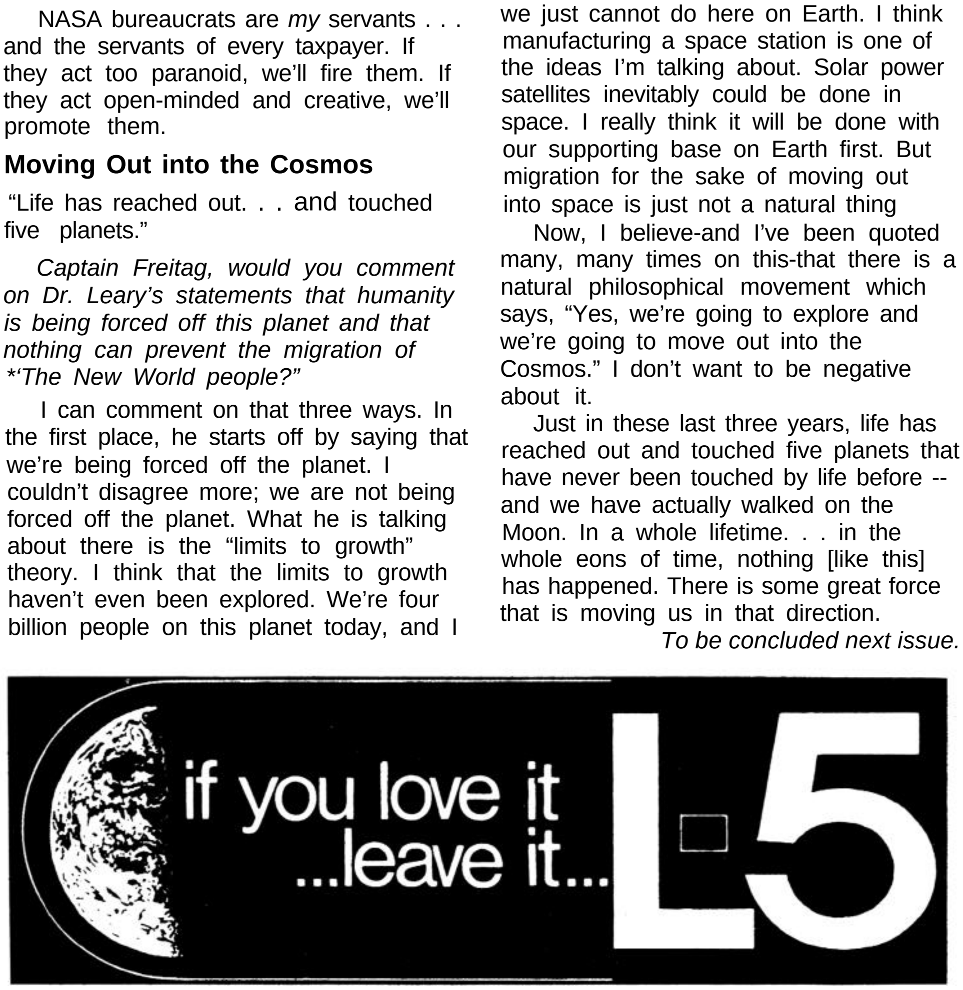
Space is an extremely hostile environment *without protection. The* implication of space as a docile place where great masses of the population would go is just not an accepted thesis at this point in time.

I think the time will come when there is a demand to go to space to do things -- and to do some monumental things -- that we just cannot do here on Earth. I think manufacturing a space station is one of the ideas I'm talking about. Solar power satellites inevitably could be done in space. I really think it will be done with our supporting base on Earth first. But migration for the sake of moving out into space is just not a natural thing

Now, I believe-and I've been quoted many, many times on this-that there is a natural philosophical movement which says, "Yes, we're going to explore and we're going to move out into the Cosmos." I don't want to be negative about it.

Just in these last three years, life has reached out and touched five planets that have never been touched by life before -- and we have actually walked on the Moon. In a whole lifetime. . . in the whole eons of time, nothing [like this] has happened. There is some great force that is moving us in that direction.

To be concluded next issue.



This bumper sticker is available from Criteria, *see the first letter on page 15.*

Conferences, Classes, Papers Called For...

1977 PRINCETON-AIAA CONFERENCE, MAY 9-12,1977

Session Title	*Special Topic*
Material Resources	Lunar Data Lunar Polar Orbiter Asteroidal Data Asteroidal Missions
Rocketry and Trajectories	Earth to LEO (inv.) Above LEO (inv.) Trajec. (inv.)
Mass-Drivers	Review thru 7/76 (inv.) MIT work 76-77 (inv.) Model tests (inv.) MD Reaction Engines
Chemical Processing	Review thru 7/76 (3 additional papers)
Large Space Structures	
industrial Operations in Space	6 papers, 15 min. each Concluding with 2 invited papers
Human Factors	Physiological params. Psychosocial Ecosystems Any topic
Products of SMF	SSPS Survey Telescopes, labs, etc. Exploration 1 contrib. paper
Systems	Systems Analysis Econometric Analysis Economic Management Structures
Social System Interactions	Education International and Legal Considerations Antropological
Summary Session	

Notes: 1) Dates were changed to 9-12 May after September A&A announcement.
2) Some topic and speaker changes may still be made, but probably not major rearrangements (main committee meetings done).

FUTURISTICS CONTEST DEADLINE

The 1977 Contest in Cultural Futuristics will focus on three areas: alternative cultural patterns on Earth; anthropological considerations in the design of the first orbiting extra-terrestrial community for 10,000 residents; and long range implications of the transition into extraterrestrial living. Considerations such as heterogenization and symbiotization in post-terresterial cultural evolution and post-sapiens biological evolution may be included.

Either essay or fiction format may be used. Selected papers will form a symposium at the 1977 AAA annual meeting. *April 1, 1977,* is the contest deadline. Rules are available by sending a self-addressed, stamped envelope to Carol Motts, Speculative Anthropology Society, 10151 Heather Court, Westminister, California 92683.

CLASS BEGINS ON SPACE COLONIES AND TRAVEL

As part of the Adler Planetarium (Chicago) 1976-77 program of instruction in Astronomy and Navigation, James Seevers is teaching a course entitled “Space Colonies and Space Travel,” January 13 - March 17. The course announcement reads:

“The possibility of building and living in space colonies during our own generation has apparently arrived. Repeated studies show that large, wheel-shaped, spinning space stations-housing and feeding 10,000 people of all ages and skills-are already feasible and can even pay for themselves by building orbiting solar power stations for Earth. We will study carefully how such colonies may be built in lunar orbit (using a 200-people base on the moon), what the pleasures and problems of living in space would be, and how solar power stations could supply energy to Earth. Finally, we will explore humanity’s hopes of traveling to other planets and perhaps even beyond the solar system to the stars.”

For further information, call (312) 322-0304 or write to the Adler Planetarium, 1300 South Lake Shore Drive, Chicago, Illinois 60605:

SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

“Who are We?” “How did we get here?” “Are we alone in the Universe?” The answers to these questions have broad, scientific implications, as well as deep philosophical, sociological and theological meaning. The Search for Extraterrestrial Intelligence (SETI) has begun . . .

The Forum for the Advancement of Students in Science and Technology (FASST), and the student programs division of the American Institute of Aeronautics and Astronautics (AIAA) invite you to take part in the search by participating in a special symposium, “THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)” to be held at the Ames Research Center, near San Francisco, February 24-25, 1977.

Conference speakers and special discussion groups will highlight the symposium dedicated to learning current technological approaches for locating extraterrestrial civilizations and evaluating possible ramifications of discovering and contacting extraterrestrial intelligences upon Earthkind.

The program will involve the following topics: *The Cosmic Picture:* Is anyone really out there?; *The Origin of Life:* Chemical and biological considerations; *Evolution of Technological Civilizations; The Search Begins:* Methods and technology needed; *Cultural Implications of Detection and Contact with Extra terrestrial Intelligences.*

Directed primarily toward college and university students, the symposium welcomes participation by interested professionals and faculty. A wide cross section of disciplines will be involved, i.e., anthropology, theology, life science, engineering, sociology, physics and astronomy.

Registration fee is $10.00. This fee includes tour, symposium materials, and special banquet with guest speaker.

The program is being developed by AIAA/FASST in cooperation with the Ames Research Center’s SETI and Educational Programs staff.

For further information, contact: FAAST/SETI, 1785 Massachusetts Avenue, N.W., Washington, D.C. 20036. Phone: (202) 483-2900 or the Ames Center (415) 965-5543.

AAS/AIAA CONFERENCE -- INDUSTRIALIZATION AND COLONIZATION OF SPACE

San Francisco Bay Area
October 18, 19, 20, 1977

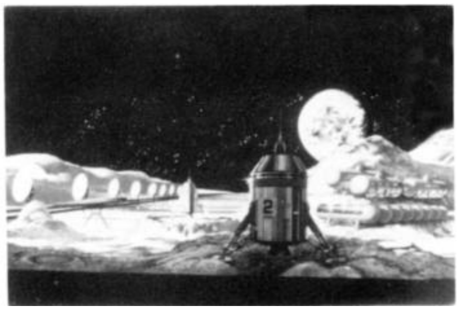
The American Astronautical Society, in conjunction with the AIAA Technical Committee, announces a multi-dimensional conference on the industrialization and colonization of space. The conference will focus on commercial activities in space over the next ten years.

There will be technical sessions on *Large Space Structures (piloted and unpiloted); Manufacturing for Profit;* and *Economical Transport Systems.* Sessions are also planned to discuss *Space Law; Space Community Planning; Psycho-Social Considerations for Space Communities;* and *Economic Realities of Space.*

Papers may consider-but are not limited to-the following subject areas:

Technical

Low-cost fabrication and assembly techniques for large structures in space
Optimum shapes of large space structures
Limits of size in space
Materials for large, light-weight space structures
Shielding techniques for communities
Design considerations for solar storm shelters
Radiation considerations: low-Earth orbit vs. geosynchronous orbit vs. cis-lunar orbit
Identification of tools needed for assembly of structures in space
Automated fabrication and assembly vs. human fabrication and assembly
High capacity power alternatives for in-space use
Control of in-space manufacturing quality
Necessary research before commercial production plants can be implemented
Methods of increasing the number of experiments in orbit
In-space inter-system interfacing techniques
Low-cost transportation techniques
Technique for high frequency launch to orbit and rendezvous
Techniques for rescue and/or return of personnel
Single person transport modes for in-space assembly
Low orbit to high orbit transport alternatives: Cost-effective solutions
Materials resources obtainable from extra-terrestrial sources



Lunar base and launch track -- Field Enterprises.

Space Law

Property rights in space
Freeports for commercial space use
The status of privately owned space objects and colonies
Legal ties of a space community to Earth
Internal legal options for space colonies
The impact of existing and imminent treaties on commercial space operations
The legal framework for intra-space cabotage
Rights of multi-national corporations in space
Rights and protection of information from space
Rights of entrepreneurs in space commerce

Space Community Planning

Architectural and structural considerations
Designing humans into the system
Person selection techniques
Analogies of Earth communities with space communities
Internal economic flow considerations
Ways of making the community economically self-sufficient
Effect of various G-levels on human activities, manufacturing processes, and agricultural efficiencies
Design of a typical room
Anticipated internal and external traffic flows
Moderate to large community shapes
Intra-community transportation methods
Food production in space communities
Recreational activities and facilities
Space medicine and health care

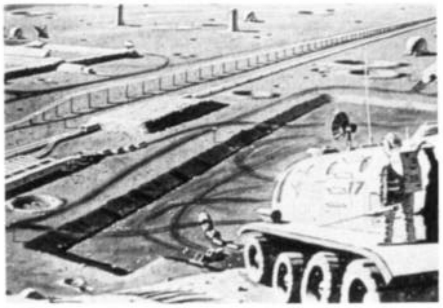
Psycho-Social Considerations for Space Communities

The effects of packing on human behavior in space
To what human need level should a space community strive to satisfy
Anticipated boundaries of stay-time in space
Ranking of services for human needs in space
Design considerations for the human element

Economic Realities of Space

Near-term economic justifiers of space activities
Perceived risk factors in industrializing and colonizing space
How to finance medium to large scale space ventures
Major cost drivers in costing space communities
Economic trade-offs: low Earth orbit vs. geosynchronous orbit vs. cis-lunar space
Economic trade-offs: large unified space structures vs. smaller independent space structures
Effects of population numbers and physical mass on colony cost
Economic priorities of commercial space activities
Earth needs for space goods and services
Bootstrap profit makers
What private industry needs to invest large amounts in space research

Abstracts of 200 to 500 words should be forwarded prior to 1 May 1977 to the Technical Program Chairman: Paul L. Sigler, EARTH/SPACE, Inc., 4151 Middlefield Road, Palo Alto, California 94303. Authors will receive notification by 1 June 1977 of acceptance of papers.



Artist's conception of lunar mine and mass driver -- National Geographic.

ORBITAL STATIONS?

Phillip Parker

Acamedician Georgi Petrov, in an interview with *Pravda* on the 3rd of September 1976, said that the "flight made by Boris Volynin and Vitely Zholobov on the Salyut-5 space station represents a substantial contribution to the development of cosmonautics. He said that space technology, making use of the high vacuum and weightlessness would also occupy a considerable place in orbital space stations, much of which might be of industrial significance.

"In time," he stated, "I think it will prove expedient to build stations designed for years and even decades of human service by changing crews of twenty to thirty. In due course there will probably be super-large, multi-purpose orbital complexes with crews of one hundred or more. Naturally, these would be constructed from components delivered from the Earth by comparatively small rockets. The construction of such craft is, of course, a matter of the next few decades. But each new experiment in the cosmos brings the time nearer."

The Salyut-5 crew remained in orbit for forty-eight days, landing in the Soyuz-21 spacecraft on August 24. The USSR has announced that several foreign cosmonauts are in training for future international flights in the 1978-1983 time frame. These cosmonauts are from other socialist countries.

US/SOVIET MULTILATERAL SPACE STATION DISCUSSED

Leonard David, Washington

NASA and the USSR Academy of Sciences have agreed on a wide range of cooperative space efforts for the future, including the possibility of an international space station.

Led by Dr. A. M. Lovelace, Deputy Director of NASA and Academician B. N. Petrov, Chairman of the Soviet Interkosmos, U.S. and Soviet technicians outlined the first stages of a renewed interest in future space cooperation. The October 19-22 meeting calls for "consideration of the feasibility of creating a future international orbital station, on a bilateral or multilateral basis."

The international space station concept would follow a number of smaller cooperative programs, with early attention paid to a "Salyut-Shuttle" program. Agreement has centered around use of a Soviet Salyut space station and a U.S.-launched Space Shuttle, for a projected 1981 rendezvous and docking and for "conducting a program of joint scientific and applied experiments and investigations."

ADVERSARY FORMAT FOR SPACE COLONY COURSE

Vid Beldavs, on special assignment from Cummins Engine Company, is designing a course entitled "Space Colonization and National Priorities" that will utilize an adversary hearing format. He will be teaching the course at COE College, Cedar Rapids, Iowa.

The students will be divided roughly into three groups- (1) committee, (2) advocates for, and (3) advocates against. Each group will have to prepare and do research in support of their respective roles. At the onset of the course the students will go through a structured brainstorming/consensus-making process to reach a decision on important goals for the country. These goals arrived at by consensus will serve as the criteria against which the various proposals will be judged.

The course will last approximately one month, meeting two to three hours a day, three times a week. The final output of the course will reflect the pro and con arguments as well as the final recommendation by the "committee." The intent at this time is to send the report to interested members of Congress as well as persons involved in the space colonization effort.

newsletters

Speculative Anthropology

Carol J. Motts, active L-5 member, has organized *Speculative Anthropology,* a newsletter covering cultural futuristics and space technology. It is billed as "The forum of the Speculative Anthropology Society," and carries news and articles on activity and speculation in the field. To subscribe, send a check or money order to Carol J. Motts, *Speculative Anthropology Society,* Newsletter Dept., 10151 Heather Court, Westminister, CA 92863.

Anthro-Tech

Anthro-Tech: A Journal of Speculative Anthropology is a new newsletter that directs itself to the study of humanity in a technological world. The study of human life in space is one of the main themes of *Anthro-Tech.* We encourage contributions of articles by L-5 readers to the newsletter. Both scientific and speculative articles will be considered for publication. The subscription rate is $3.00 for four issues. Requests for subscriptions should be sent to Darlene Thomas, Lock Haven State College, Lock Haven, Pennsylvania 17745. Please indicate if you wish to start a subscription with the first issue, which was published Fall, 1976.

inside the L-5 Society

The catalog of slides available from the Society didn't make it into this issue; we've been buried by orders from our Christmas mailing and haven't put it together yet; rather than hold up the newsletter we prefer to mail the slide brochure separately, so look for it in your mail soon.

Special mention just has to be made at some point of Vid Beldavs (see article above). Seems a week doesn't go by without a phone call from him with news about NASA or ERDA's plans for space industrialization or the lack of same. V for Victory, Vid.

Existing L-5 local chapters and those in the process of formation (or re-formation) should let us know when and where they plan to meet. If we can have the information by the first of the month, it can be announced in that month's *L-5 News.*

Deadline for other material-articles and longer news reports-is two weeks earlier.

The November issue was not actually mailed until December 2, but it looks like the December *L-5 News* will be entrusted to our postal friends on about December 22. We hope to eventually pull that date up (earlier) by about one week.

If you have a June 1976 *L-5 News,* it's a collector's item. We are no longer shipping that particular back issue except in xerographic form. Back issues are $1.00 each, printed or xerographed.

Other items for sale by the Society are . . . (deep breath) . . . the two Bernal Sphere postcards (interior and exterior views), 15¢ each or 50 (of one kind) for $3.00; posters on the same subjects, $3.50 each (two or more, $3.00 each); slides: nontechnical set, $8.00 (16 slides), technical set $8.00 (16 slides), supplemental set, $4.00 (8 slides), lecture information packet, *$1.83; High Frontier* by G. K. O'Neill, $7.50 (special price, see below); reproductions of published and unpublished articles are 50¢ per title plus 7¢ per page -- send a self-addressed, stamped envelope for a list of what is available (if you can't wait, order the "complete set" of copies of previously published materials for $5.82).

Important: please add $2 handling to any order.

The regular retail price of Dr. O'Neill's book is $8.95, but our $2 handling charge enables us to offer it for an apparently lower price.

WEST EUROPEAN BRANCH -- ORGANIZERS REQUIRED!

In November 1976, the West European Branch of the L-5 Society was one year old and the current coordinator Phillip J. Parker, has been in office for the same time. The office of coordinator is now open and applications are invited from members for the position.

Duties of the coordinator include servicing membership enquiries, preparing the branch newsletter, dispatching both U.S.A./W.E. newsletters, maintaining the cash flow accounts, exchanging correspondence with members in West Europe/U.S.A., liaison with L-5 Society HQ, preparing publicity and doing publicity stands and generally looking after L-5 interests in West Europe. It is essential that the coordinator have access to a typewriter and a duplicating machine.

If you would like to become coordinator, please write to Phillip J. Parker, Director, L-5 Society (West Europe), 40 Lamb Street, Kidsgrove, Stoke-on-Trent, ST7 4AL, England, U.K.

letters

Enclosed please find our contribution to bumper-sticker art. The message will not be lost on you, since you were among the first to see the sense in space colonies. If you are interested in having more of the same, contact us-we are selling them at cost: $2.00 each [see page 11].

The sticker was created to express our viewpoint during a conference held here in the cities (Space Colonization and Exploration -- December 4 and 5, 1976). *Criteria* was, and still is, based upon experimentation within the built environment; our interest in space colonization is more recent, but equally serious. Question: are there any L-5ers in our vicinity?

Lee Dunnette
Criteria
100 First Street North
Minneapolis, Minnesota
55401
(612) 338-4761

I would like to comment on some of the cost comparisons recently published in the *L-5 News.* These comparisons are likely to be meaningless. Unless a great deal of care is taken to ensure that all ground rules, assumptions, and costing methodologies used to derive the values being compared, are truly equivalent, invalid results are probable. To illustrate: suppose a system with no fuel cost (e.g., a solar power plant) is estimated to cost $2000/KWe. This value must be amortized over a 30-year plant life, including interest costs. Analyst A selects a discount rate of 7½%, resulting in a capital charge factor of 0.838, and computes the busbar power cost as follows:

$$\text{cost in mills/kWe} = \frac{1000 \times \$2000/\text{kWe} \times .0838 \text{ per year}}{8766 \text{ hours/year} \times 0.9 \text{ plant factor}} = 21 \text{ mills/kWe}$$

The 7½% discount rate reflects a typical cost of money for a constant-dollar analysis (no inflation). Utilities presently, in our inflating economy, pay 10% to 12% for their money and include taxes and insurance in their capital costs, resulting in a representative capital charge factor of 0.15. Thus a $2000/kWe system if bought today by a utility would be calculated to have a busbar cost of capital investment of about 38 mills/kWh.

Another analyst might consider a $2000/kWe system (today's estimate) available 20 years in the future, in an economy inflating at 5% per year, and would calculate a capital cost in then-year dollars of $5307/kWe. With the 0.15 capital charge and a plant factor as low as 0.6, the estimate of busbar power cost is 151 mills/kWh.

These examples do not exceed the range of assumptions, ground rules, and methods used by various analysts. Further differences clearly exist in degrees of technical conservatism, cost estimating conservation, and in handling of such matters as operating costs, profit, distribution costs, amortization of development costs, and government subsidy.

My view is that cost comparisons, between today's depletable energy sources and the various possibilities for future nondepletable energy sources, are not constructive. Someday we have to move to nondepletable systems. Cost and technical uncertainties for all such systems are great enough that a rational selection cannot be made now. Any nondepletable system that exhibits promise of technical feasibility and economic practicality (the SPS clearly falls in this class) should be pursued vigorously until a valid reason is found to discard it. Estimates of the time to develop nondepletable systems and implement them on a large scale are roughly equal to the estimates of useful lifetime remaining for depletable energy sources. Selection of a "best" nondepletable option today is not a rational strategy. What if we found out years later that we couldn't make it work work?

Gordon R. Woodcock
Bellevue, Washington

I am writing for two reasons: first, I hope the L-5 Society will not confine its activities merely to establishing Earth Orbital Space Colonies, but will also go even further-to the stars. It is never too early to want to go further, and there is plenty of room in the Universe for other ideas and approaches. I believe the L-5 Society will never disband.

Secondly, I want to answer those who push space colonies because they will solve all our problems. No, space colonies will *not* end: war, hate, over-population, evil, pollution, politics, or stupidity. These things happen because we are humans. And if they *are* solvable, it could easily be done here on Earth.

But there is a very good and necessary reason for us to build these marvelous things in space: because we are civilized. And all civilizations build for a higher purpose, rather than mere utility. Examples of this abound, but let us look at those lovely cathedrals which rise so fantastically into the sky. From the end of the Roman Empire until the crusades, nothing substantial was built, for the people knew the world would come to an end 1,000 years after Christ. But the dreadful day came and behold, the Earth remained intact! In less than three hundred years, every village had its own cathedral. Everyone labored to raise these stone temples, noble and peasant alike. And everyone could enter these churches (except for the infidel!), irregardless of class or nationality. Cathedrals were built because the people believed in the *future.*

And we, of the L-5 Society, believe in the future. We will work to preserve our beloved Earth, but we shall also strike out for the stars! And space colonies shall be just one more manifestation of humanity's need to drive forward.

P.S. About immortality: our children, monuments, books, and artifacts make us immortal. If we each lived 1,000 years, progress would come to a standstill, for we change only because we fear the oblivion of death. Besides, we'd be just as destructive and neurotic as today!

Elaine Meinel
New York, New York

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NL612

L-5 SOCIETY
1620 N. PARK AVE.
TUCSON, AZ 85718

NAME: ____________________

COMPLETE ADDRESS: ____________________

AFFILIATION (OPTIONAL): ____________________

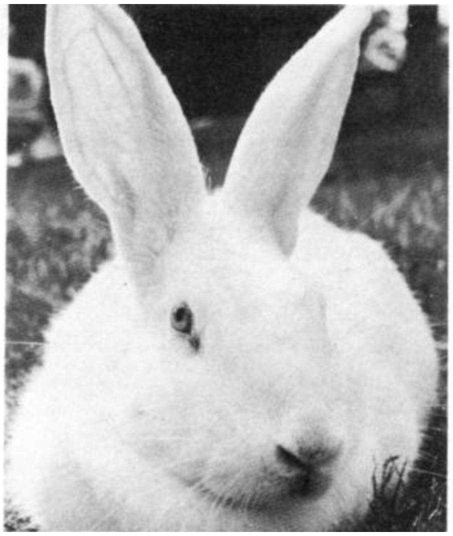
TITLE OR POSITION (OPTIONAL): ____________________

I am am not interested in being active locally. Phone (optional) ____________________

__ Please enroll me as a member of L-5 Society ($20 per year regular, $10 per year for students). A check or money order is enclosed. (Membership includes *L-5 News,* $3 to members; the balance -- $17 or $7 -- is a tax-deductible donation.)

__ Please enter the above as a nonmember *L-5 News* subscriber ($20 per year). A check or purchase order is enclosed.

__ Enclosed find a donation of $__________. (Donations to L-5 Society are tax-deductible.)



I have noticed that the idea of using rabbits for food on the L-5 colony has been brought up in the last few issues of the newsletter. I feel that this idea should be more carefully examined. A rabbit is by no means an ideal animal to use as far as converting waste materials to food is concerned. After you take away the big feet and the ears, there isn't much left to eat on your average hare. The famous ability of rabbits to "multiply" is also greatly exaggerated as they refuse to breed if the slightest disturbance in their environment occurs. If a cat walks by their hutch, they will become nervous and unsociable.

As a suitable substitute for rabbits I would suggest that eternal friend of science, the guinea-pig. It eats approximately the same kind of materials as a rabbit, but it is composed mostly of edible parts and has a much more reliable breeding cycle (which is usually 1 litter of 2, every 3 months). Both animals, however, suffer from the same disadvantage. They produce large quantities of droppings that would be absolutely useless for anything, unless you wanted to start showers of meteorites with them.

Don Hutton
Burlington, Ontario

It is true that rabbits butcher out to only about 50% of live weight. However, of that amount, 90% is directly usable food (the remainder being bone and gristle). Chicken and beef, on the other hand, are full of big bones and gristle. According to Professor Ken Olson, a specialist in rabbit raising, rabbit meat has a larger percentage of edible food than that of any other domestic animal.

As far as food conversion is concerned, rabbits are highly efficient in converting grain and alfalfa. A given acreage planted in an alfalfa/grain mixture could produce as much rabbit protein as the same acreage in grain alone. (Soybeans would produce about 50% more protein.)

Having raised rabbits for many years, I am impressed by their health and ability to multiply. Perhaps they are more reluctant to breed in Canada. It should be noted that the rabbits were first domesticated in West Africa about 1000 years ago; as they are native to a tropical region they may have health and breeding problems in northern climates.

Guinea pigs, first domesticated in the Andes, may be worth raising for food as their diet and feed conversion are comparable to that of rabbits Their low reproductive rate is a problem, though. Commercial rabbitries in the Southwest U.S. produce, on the average, 42 fryer rabbits from each doe. If guinea pigs are limited to 8 young per year, a far larger inventory of breeders will be required. Their small size also increases the expense of butchering.

Rabbit meat is more expensive than chicken meat because chickens are raised on such a large scale that their raising and butchering has become largely automated. (Chicken meat is also cheaper because the high quality protein they need comes largely from fish meal. In space, in the absence of massive oceans to harvest, chickens might be far more expensive than plant-eating animals)

No organic gardener would let you get away with that remark about rabbit and guinea pig manure! -- CH

In the October L-5 News, one of the chief objections put forward by Keith Henson concerning Bob Parkinson's proposal to establish a permanent Lunar colony was that obtaining continuous solar energy would be impossible since there is a fourteen day Lunar night, and that it would be too expensive to build nuclear power stations to make the base economically feasible.

On this count, he is wrong, for there is a place where the sun shines continuously: near the Lunar South Pole, by the Leibnitz mountains. A Lunar colony could operate easily at this point. *(See* H. E. *Ross, Space Flight,* vol. 17, pp, 409-410).

Dr. G. Matloff, NYU
New York, New York

I have certainly always regarded space travel as the means to insure the survival of the human race as a species. I figured seed groups of people relocated on planets here or in other stellar systems would be the means of that survival. I had assumed that the great mass of humanity was doomed. I am now convinced that the exploitation of even our immediate spatial neighborhood is a means of achieving universal affluence -- Jerry Pournelle's "survival with style."

I hadn't realized just how pessimistic I was until I became optomistic. I'm busy with extensive professional, educational, and family activities; but I'll make time for activities in *this* effort.

Bruce R. Quayle
Utica, Michigan

I would like to second the suggestion that the L-5 Society change its name to "Space Colonization Society" made by David M. Fradin in his letter to the editor in the September issue. Our organization is now entering a period of rapid expansion which can be accelerated by enabling association of our major goal with our name. Perhaps a survey of suggested names through the newsletter would be appropriate.

John Moran
Los Angeles, California

MAILING LIST

We have received some worthy requests to exchange mailing lists. Also, local chapters of L-5 Society have requested lists of members in their areas.

To protect the privacy of those who abhor unsolicited mail, we request anyone who does not want to be listed in distributions of our mailing list to specifically inform us of that preference and we will warn our computer. *Semper fidelis*

LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

L5 NEWS

VOLUME 2, NUMBER 2 A NEWSLETTER FROM THE L-5 SOCIETY FEBRUARY, 1977

Opportunities for Students!

NASA HOPES TO FUND STUDENT STUDIES

Plans are underway at NASA Headquarters to ask Congress to fund students to work on space industrialization and settlements in fiscal year 1978 (which begins next October). Those interested in this program should send pre-proposals to Robert F. Freitag, Deputy Director, Advanced Programs, NASA, 600 Independence SW, Washington, D.C. 20546, and to John Billingham, LT: 229-7, NASA Ames Research Center, Moffet Field, CA 94035.

Freitag is interested in students who wish to do in-depth, 2-10 year studies. He warns people not to get their hopes too high, however, as it is ultimately Congress and the President that will decide whether hundreds of students next winter will be working on the L-5 concept.

The following list has been suggested as a source of ideas that may be worth further study. Robert Freitag adds that some topics not included in this list, especially those in the social sciences, may also be of interest to those in NASA who, Congress and the President willing, will be funding researchers next year.

Those interested in sending in preproposals should mail them in as soon as possible, as NASA is planning to finish its budget request by mid-March and needs input from students.

Study Topics List

I. Selected most urgent research recommendations

Systems Studies (resulting in reports) :
  1) SSPS-Brayton Cycle: Optimization for Lunar Materials
  2) SSPS-Photovoltaic: Optimization for Lunar Materials
  3) Free Flyer (Shuttle Payload) for Rotational Parameters Studies (Human-rated):

(Continued on page 15)

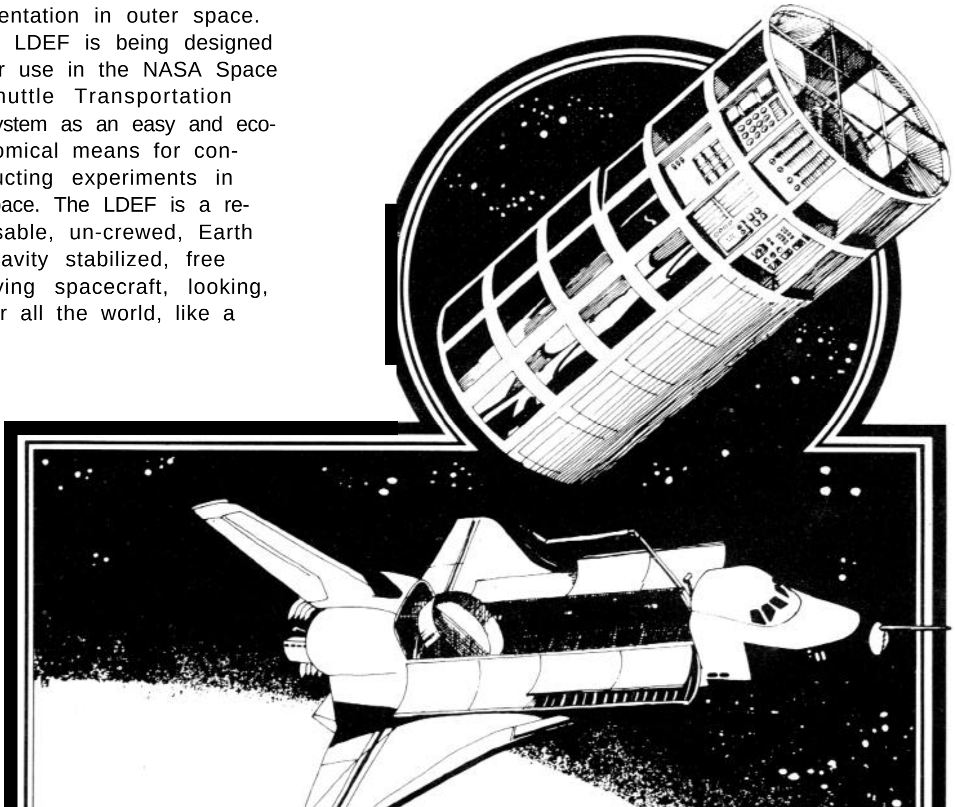
LDEF AND THE EDUCATIONAL COMMUNITY

Leonard David, FASST

There's going to be something new over the horizon -- about 300 nautical miles straight up, or 556 kilometers for you metric afficionados. Pronounced in the most suitable acronym that NASA can drum up, LDEF (spoken "el-deaf") stands for Long Duration Exposure Facility. It might not impress you at first, but it may provide an inexpensive ticket for student-teacher experimentation in outer space.

LDEF is being designed for use in the NASA Space Shuttle Transportation System as an easy and economical means for conducting experiments in space. The LDEF is a reusable, un-crewed, Earth gravity stabilized, free flying spacecraft, looking, for all the world, like a space-based automat. The structure is a twelve-sided, bolted metal frame cylinder, some 30 feet (9.14m) long by 14 feet (4.27m) in diameter, weighing in at about 6,000 pounds when empty.

The key to its simplicity lies in its 76 separate "trays" which are mounted to the framework of the LDEF. The experimenter has an option of having an experiment exposed or covered to the space environment while sitting in its tray. No word yet on white-walls, air-



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conditioning or AM-FM radio!

The trays themselves measure 50 inches (1.27m) by 38 inches (.97m). Depth of the tray is varied, either three, six, or twelve inches depending on requirement. Experiments will be accepted from full use of the tray to within any multiple of 1/6th of the tray. It is required that no experiment can protrude beyond the planes defined by the 12-sided LDEF structure.

LDEF Mission Profile -- Present plans call for the first LDEF to be carried onboard the Space Shuttle in 1979. Once in orbit, the Shuttle mission specialists will remove the LDEF from the Payload bay by using the Remote Manipulator System (RMS). Using this mechanical arm, the LDEF will be aligned to the local Earth vertical, and all LDEF motions will be dampened. The Shuttle will then depart the scene, leaving the LDEF and its hitch-hiking experiments alone in the vacuum of space.

Planned exposure time will be from six to nine months, with an altitude decay of about 20 nautical miles, after which a subsequent Shuttle flight will capture the LDEF for the trip back to Earth. Upon return, the LDEF trays will be shipped to the various experimenters for analysis

Wide Range of Possible Experiments -- Experiments for LDEF can be developed for a passive or active mode while in space, although the first LDEF will involve only passive experimentation. These experiments would require data measurements taken before and after space exposure. Active experiments, for later LDEF flights, which require such systems as power, data storage, must be provided by the experimenter and be an integral part of the experiment assembly. Each LDEF experimenter will be responsible for establishing the criteria necessary to ensure that the experiment is safe to fly and will not adversely affect the other experiments on board LDEF.

LDEF -- An Equal Opportunity Program -- For those of you with eyes that are now "space-glazed," please note that LDEF is not exclusively a high school or college program. Also, LDEF is not a program to make a student or teacher “the first one on your block” to fly an experiment in space.

The LDEF is, however, designed to serve as a meaningful interface between NASA and the academic community. Experiments will be chosen on a selective basis, by a panel review and evaluation of specific proposals from those wishing to participate in the LDEF program. Experiments will come from numerous groups, including education, government and industry.

Under sponsorship of NASA, the Universities Space Research Association (USRA) has been contracted to be the prime focal point for involvement in the LDEF concept. Both experienced and inexperienced space researchers can seek assistance from the USRA, including possible sources of funding for your space experimentation.

The chances appear good that students and teachers, perhaps one of you reading this article, may participate in the LDEF program. The range of possible experimentation is limitless, from effects of zero-gravity on plants, to solar and cosmic radiation studies. It looks as if LDEF may provide the simplest, most inexpensive way of developing high school and college participation in space. The missing ingredient is you, a creative idea and a willingness to get involved!

To get involved, contact Bill Davis, LDEF Program office, Universities Space Research Association, P.O. Box 3006, Boulder, CO 80303.

FASST is developing student and teacher awareness of the potential of LDEF. At present, FASST is in the process of cataloging student experimenter interest, hoping to insure a smooth flow of student participation in the LDEF and other Shuttle programs. For those wishing to be included in such a catalog, notify the Washington headquarters of FASST: 1785 Massachusetts Avenue, N.W., Washington, DC 20036, Attn. Shuttle Student Experiments.

PROFESSORS DEBATE THE “HONORABLE” FUTURE OF NUCLEAR POWER

(FASST News Service, Washington, D.C., 11/22/76) -- Two of the most prominent names being called upon by university groups interested in the discussion of nuclear power are Dr. Barry Commoner and Dr. Norman Rasmussen. At a recent international meeting in Washington, D.C., sponsored by the Atomic Industrial Forum and the American Nuclear Society, these two energy gladiators treated a standing-room-only crowd of over 900 to a lively “debate” on what this country should be doing in regards to nuclear energy development.

Speaking first, Dr. Commoner, a professor of environmental sciences at Washington University in St. Louis, presented his opposition to nuclear power on economic grounds. He does not believe that nuclear power can survive the tension that is being generated between the financial costs and the actual benefits. Because of our “technical immaturity” in determining all economic factors related to nuclear plants, he pointed out that things such as legal fees, security costs, and costs of waste disposal are not always included in the price of producing nuclear energy. For this reason he believes that “the economic costs of nuclear [energy production] are high, rising, and uncertain.”

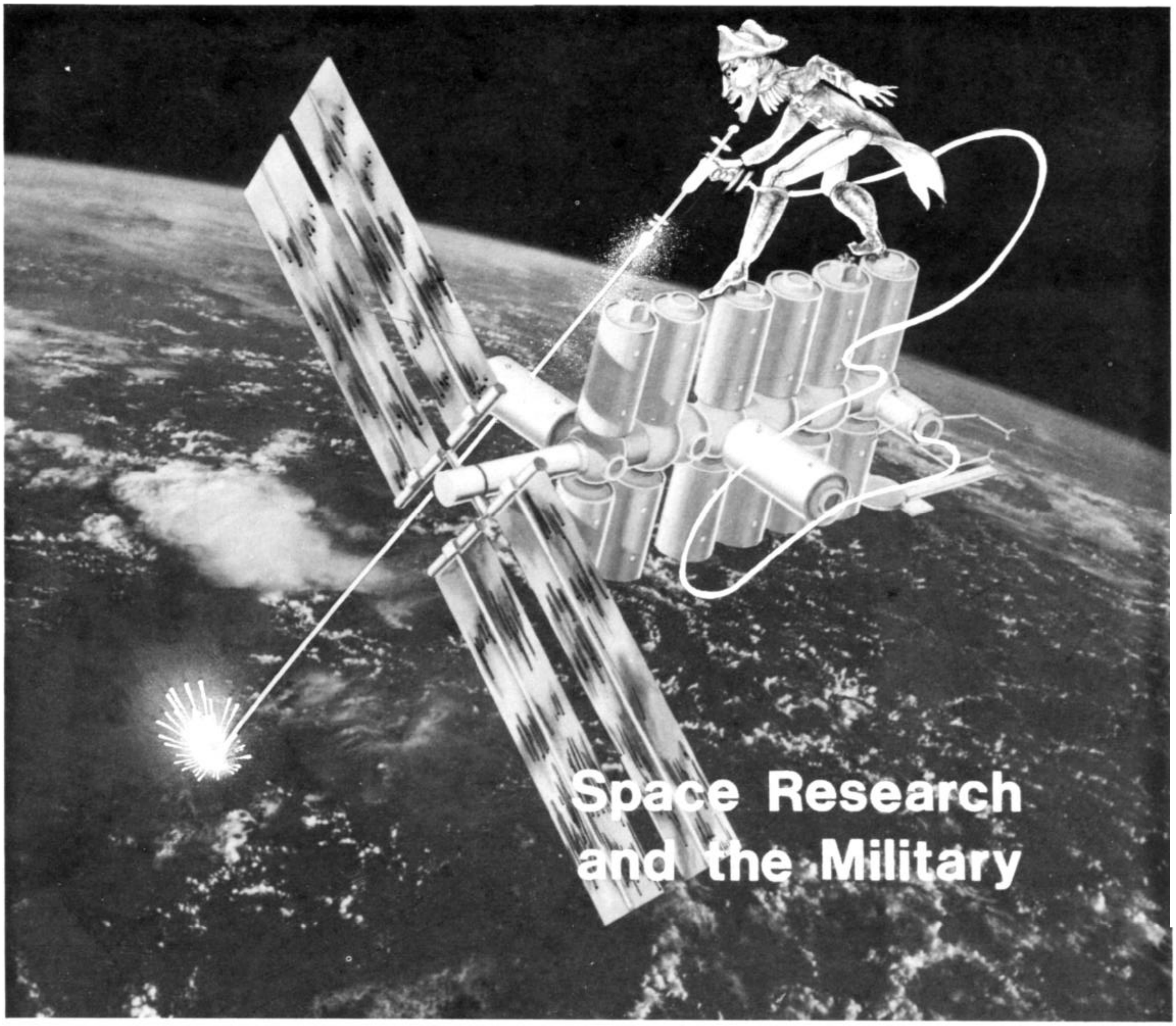
Dr. Commoner also argued that the cost of nuclear power would increase exponentially as the price of uranium increases with dwindling ore supplies. Much of his argument was based on comparisons of nuclear costs to that of coal, which he claims would be cheaper, and not escalate as quickly as nuclear. (In the question and answer session, member of the audience angrily disagreed with Commoner’s graphs and statistics which gave this comparison, claiming that the information was over a year old and inaccurate.)

In closing, Commoner contended that nuclear power has not been able to sustain itself as an ongoing energy source and as a viable alternative to fossil fuels. He interpreted President Ford’s recent call for a “delay in reprocessing nuclear fuel until nonproliferation can be assured,” as a signal to the end of the entire nuclear program. He turned the arena over to his opponent with the charge that “The only honorable thing to do now is figure out how to begin the shut-down of nuclear power in the U.S.”

Chairman of the nuclear department at the Massachusetts Institute of Technology and author of the nuclear reactor safety report which bears his name, Dr. Norman Rasmussen did not directly challenge Commoner on the economic arguments. He preferred to leave that approach to those with more expertise in economics. Instead, Dr. Rasmussen focused his remarks on the consequences of not utilizing nuclear energy.

Rasmussen stated that Commoner had “omitted to tell you where we’re going to get power without going nuclear.” He mentioned that there were several ways that we could help to relieve some of our energy problems-the most obvious being to practice conservation. “Any country that does not implement a strong conservation program is unethical,” the MIT professor stated. However, he also noted that even with a strong conservation program, there will still be a need to increase our capacity to generate electricity. In reviewing energy alternatives, Rasmussen believes that it will take a combination of all available sources to meet our energy needs. He found it ironic that Commoner, a strong environmentalist, would advocate the extraction of coal over further development of nuclear power.

Rather than criticizing the fact that after 30 years nuclear power is producing only 10% of the U.S. electrical needs, Rasmussen challenged the opponents to recognize that this is equal to the total output of hydroelectric power generation. He proposed that Commoner come up with another energy source that could develop more rapidly than nuclear power has, while filing environmental impact statements on each plant site.



Space Research and the Military

Excerpted from an article by John Holt in Skeptic *No. 17, Jan/Feb 1977.*

A great danger of space research is that it will sooner or later be turned to military purposes. It is military research in disguise, a hawk in dove's clothing. I don't claim that the Space Salesmen *want* this to happen, only that it is certain to happen whether they want it or not. One of the reasons why science is too important to be left to the scientists is that they have been so poor at foreseeing what life-destroying uses the military would find for their clever inventions. When the laser was first described to the public, it took me only a few minutes to realize that science had at last made into a dreadful reality the death ray of the comic strips. But it was not until some years later, when there began to be reports of intensive American and Russian military research on lasers, that scientists began to express any public concern about this possibility.

Let us take another example. The *New Scientist* of September 30, 1976, describes the latest American cruise missile: about 20 feet long and a little over a foot and a half in diameter, it can be launched from submerged submarines, surface ships, land vehicles or aircraft and can travel almost 2,000 miles and deliver a one-megaton warhead to its target with an error of less than 100 yards. Flying very low, it is almost undetectable by radar and there are now no effective countermeasures against it. When in production, each of these will cost only about half a million dollars, one-thirtieth of the cost of a modern fighter. Since all new weaponry finds its way quickly into the international arms market, we can expect that soon many of the nations with sufficient nuclear materials to make bombs will have some of these little devices to deliver them.

The connection between the cruise missile and space research is this. The missile is guided to its target by matching radar signals from the ground over which it flies with a very accurate contour map of the terrain programmed into it beforehand. These extraordinarily accurate maps were obtained from satellites. Without such maps, this missile could not work. Moreover, the extremely accurate knowledge we have of Russian territory has encouraged our military leaders to consider seriously and plan for a *first-strike* strategy, in which we would bomb all of Russia's missile launching sites before they dropped any bombs on us. No doubt they have similar maps and similar plans.

In spite of all we have learned about the horrors of science misapplied, the scientists just don't seem able to ask themselves, as they work away busily on this or that magic toy, "What might some bad person do with this?" So we must ask the question for them. When we ask this question about space research, we get some very disquieting answers. One of the things the Space Salesmen tell us is that by using materials mined on the Moon or the asteroids, we can very easily (there being no gravity) build out in space huge solar generating stations. These would trap large amounts of sunlight in collectors or reflectors, use it to generate electricity, turn that electricity into microwave energy and beam that energy down to collectors on Earth, where it would be turned back into electricity, thus (so they say) solving all our energy problems. At first blush, it sounds quite attractive. But suppose someone used the enormous output of these multi-megawatt electric generating stations to power a laser or group of lasers aimed at the Earth's surface. This would be an ultimate weapon indeed. The nation that owned it could deny access to space to any other nation; destroy any missiles launched on the Earth's surface; destroy a nation's nuclear or other power plants, or anything else they wanted to destroy; or even use it as a weapon of political assassination. (Who, without going underground, could escape such a Finger of God?).

When nuclear power was first developed, the military played for a while with the idea of a nuclear-powered airplane that could stay up for months without the need to refuel. On Earth, in Earth's atmosphere, it proved impractical; to protect the crew from nuclear radiation they needed so much shielding that the plane would have been too heavy to get off the ground. They gave up the idea for aircraft, though as we know, it worked fine for submarines. Why not then, for space "submarines?" Suppose we did learn how to mine, refine and process metals on the Moon and in space, and to make in space massive human habitations. Suppose we then developed a nuclear or hydrogen propulsion system for some of these space subs. Suppose we put enormous nuclear- or hydrogen-powered electric generators in these ships and used them to power the kind of superlasers I have just talked about. The nation or group that could put a few of these ships in space would have the means to rule, or at least destroy, the world.

As far as we know, which may not be very far, the military is not doing this sort of research now, for the very practical reason that these possibilities are too remote and risky to be worth spending money on. As rich and wasteful as they are, the armed forces of the world's nations are not so rich that they can afford to spend many tens or even hundreds of billions of dollars on projects which might have only a very small chance of being successful and which would in any case take a generation or two to complete. However, if space technologies should become perfected enough to be militarily useful, the military will then take them over. One thing we ought to have learned by now is that anything that can be used for military purposes will be. If there is military advantage or wealth to be had in space, nations that are fighting on Earth for wealth and military advantage will fight for them in space as well.

The rest of the article is much like the above. The L-5 staff would appreciate it if our readers would comment on this article in letters to the L-5 News, *and to* Skeptic, *812 Anacapa St., Santa Barbara, CA 93101.*

THE CONSEQUENCES OF EXTRATERRESTRIAL COLONIZATION
A Paper Presented to the American Anthropological Association, November 20, 1976

Michael A. G. Michaud

"The most profound effect of extraterrestrial colonization may be on humanity's self image."

Until now, the study of humanity has been limited to this biosphere-a thin veneer of earth, air, and water on the surface of our planet. During recent years, we have become conscious of the finitude of that biosphere, and of the limitations it might impose on the human future. But now we are on the edge of a new dimension of human existence, of new settings for human behavior and social interaction; we are about to expand the human sphere beyond the Earth into that larger environment we call space. Already, humans have lived in small artificial biospheres in space-Skylab and Salyut -- for as long as three months. Within the next ten years, we will see permanent inhabited space stations in orbit around the Earth, with groups of three to twelve humans residing there for months or longer.

Space stations will lead, perhaps unintentionally, to the colonization of space. As humans stay longer and longer in orbit, and as they make these artificial biospheres safer, more comfortable, and more self-sufficient, some workers and their families will become long-term residents, no longer returning periodically to the Earth.

In that expansion to new biospheres lies a potential discontinuity in human affairs, a change of scale, new access to energy, resources, and living space, and new visions of possible human futures. In it also lies opportunities to explore new ways of organizing human societies, to study humans in new environments, and to understand better what humans really are.

In each stage of extraterrestrial colonization, there will be a first, pioneering generation which is likely to be tied closely to Earth by memory, culture, training, and, for geolunar colonies, occasional travel. That generation will carry into space the values of Earthbound societies. Yet it will be different in motivation, for these humans will have chosen to leave the familiar Earth for new opportunities and new challenges. Originally, many may be assigned by governments or other organizations to staff stations, or work in factories which may be like company towns, but many may go to seek higher incomes, adventure, a test of their abilities, or new beginnings to their lives. Such motivations would shape the social values -- and perhaps the social structures -- of the first colonial generations.

Other colonists may want to escape the limitations, frustrations, and inadequacies of Earthbound societies, and may hope to create utopian societies in space. But this may be too optimistic. The first extraterrestrial colonies will not be paradises, but places of work; space colony proponent Gerard O'Neill said that they might be more like a construction camp on the Alaskan pipeline than laboratories for sociological experiments.

Self-selection will be limited by the selection processes of the governments and other organizations which send up the colonists. Since their investment in the first wave of colonization will be very large, and since they may have purposes other than colonization in mind, these governments and organizations will insist that the first colonists be chosen in such a way as to increase the prospects for success and, in some cases, economic return. The colonists and their performance will be watched from Earth; there will be a public demand for accountability, and a low tolerance for waste or failure. There will be pressure on the colonists to meet the expectations of non-colonists. Those who finance the colonies will expect loyalty and a certain degree of discipline, and will expect the colonists to demonstrate values esteemed by the originating society. There may be little patience with unconventional values or behavior.

The influence of the sending societies on the colonists is likely to be greatest during the first generation of each wave of colonization. The earliest colonization ventures at each stage of the human expansion will tend to be the most uncertain, and the most in need of support from and contact with the Earth. Earthside societies will control the selection of the first generation of colonists, thereby determining the composition, educational and cultural backgrounds, values, and loyalties of the initial colony populations. However, these Earthside influences will tend to attenuate as the colonies produce, acculturate, and train their children, as the colonies achieve a greater degree of economic and technological self-sufficiency, as the time/distance/energy factor grows in importance with increasingly remote colonization, and as the colonies generate new colonies themselves. Early residents in space biospheres may see them only as jobs, but this attitude will tend to change as stations become colonies by acquiring permanent populations. Later residents may identify increasingly with the success or failure of their colonies, and may come to regard them as permanent homes.

Extraterrestrial colonists will not easily escape their evolution, the natural forces that have shaped humans, or the social influences that affect us on Earth. Extraterrestrial colonization will be a test of human individual and social adaptability, as well as of compensatory technology. The design of extraterrestrial habitats will have to draw on anthropological knowledge to ease that transition to new environments by giving artificial biospheres the qualities most needed for human psychological and social well-being, as well as physical survival.

The colonies will be influenced by their natural environments, which are likely to be hostile to life. Colonists on natural bodies beyond the Earth will have to protect themselves against unbreathable or non-existent atmospheres, and against radiation, and may spend most of their time within closed artificial biospheres. Space colonies will be surrounded by the near vacuum, extreme cold, and powerful radiations of space. Colonists will be sensitive to the fragility of their human-made biospheres, and their dependence on human technology and closed ecological cycles. Colonists may feel the psychological effects of confinement, with a sharp distinction between a hospitable inside and a dangerous outside. They also may feel a sense of physical isolation from other humans and their concerns. They will recognize the need to be as self-sufficient as possible. These new environments, this isolation, this sense of vulnerability, may encourage closely knit societies, with a sense of identity and shared purpose.

Individual colonists may need, more than on Earth, the reassurance of role definition and purposeful work, and peer approval. Early colonies may have specific tasks to perform, such as manufacturing, research, or exploration; those tasks may define roles and behavior. There may be no easy escape from social pressures within a closed artificial biosphere, especially in more remote colonies. Therefore, we should be cautious about creating utopian expectations for the first generations of extraterrestrial colonists.

Early colonies may put a high value on reliability and technological competence. Selection may emphasize technical skill, stable personalities, self-discipline, and some degree of altruism over extreme individualism and self-satisfying behavior. The establishment of experimental forms of social organization may have to wait for later generations, and may be limited to the most hospitable and least vulnerable biospheres.

Extraterrestrial human colonies, composed of skilled persons in new and often difficult environments, may prove to be among the most rapidly changing societies in history after the first generations. The first generation in each colony may be firmly rooted in Earthbound societies and cultures; later generations, born in the colonies, may increasingly follow separate social and cultural evolutions, diverging from the Earthbound and from other colonies.

The response of the colonial society to its environment will lead to growing social, behavioral, and value differences between the colony and the originating society. The demands of living in a closed artificial biosphere in space or on a harsh new planet will require different social interactions, and perhaps new belief systems, forms of political organizations, legal systems, and loyalties. Each colony will develop its own approach to the socialization of new generations, and its own ways of defining and assigning social roles.

The first wave may require the pioneering and work-oriented values of a frontier society; later generations may have more latitude for diversity in attitudes and behavior, and a lesser degree of discipline. As the sense of shared risk and task orientation lessens, colonists may become more concerned with personal, social, and political problems, and divisions within the colony may begin to grow. The growth and evolution of a colony may reduce the self-evaluated significance of the role of the average colonist at the same time that the task of survival and self-sufficiency seems less urgent, encouraging latent tendencies toward alienation and divisiveness. The colonists could create threats to their own survival by dividing a society which must work together for survival and economic viability, or by acts especially dangerous in a closed biosphere, such as the use of weapons.

There may be growing divergences between colonies on natural worlds and space colonies. Those on natural worlds, especially a planet like Mars, may have vast frontiers before them, room for growth, and a sense of expansiveness, and perhaps a situation more conducive to individualism and social mobility. Closed artificial biospheres, without an explorable “outside,” may be more likely to encourage tendencies toward hierarchical social structures, role assignment, and cultural and ideological conformity. These differences may lead to different values and different forms of social organization.

Extraterrestrial colonists eventually will begin to diverge from the Earthbound in the physical sense due to the demands of new environments, particularly as new generations are born in space or on other worlds. At first, this will be a minor problem, as the inhabitants of geolunar colonies may be able to return to Earth easily and frequently, and to intermarry with the Earthbound. However, travel and intermarriage may become more difficult and less frequent as the sphere of colonization grows and distances lengthen. Low-gravity worlds such as the Moon, Mars, and the asteroids may encourage such extensive adaptation that colonists will not be able to live comfortably in Earth gravity; they may become permanent exiles from the Earth.

The more that later generations of colony populations are isolated from the Earth and from each other in new environments, the more we will see gradual genetic drifting in response to environmental pressures, including low or zero gravities, different exposures to natural radiations beyond Earth’s magnetosphere, and perhaps different natural chemistries or alien biota on other worlds. For interstellar colonies in particular, genetic pooling with Earth and other colonies may be rare or nonexistent, producing isolated gene pools. In some cases, there may be deliberate selection of colonists for certain genetic characteristics, based on values or interpretations of needs in new environments. Eventually, genetic drifting may become so great that inter-breeding with Earthbound *Homo sapiens* will no longer be possible; new and divergent species may emerge, better adapted to their new environments.

Scientific arid technological advances might open up new options, allowing us to exploit environments that otherwise would be uninhabitable. Surgical or chemical techniques might be used to prepare colonists for exotic atmospheres or alien biota. The development of genetic engineering may coincide with the colonization of space, allowing more purposeful pre-selection and pre-adaptation to improve the colonists’ prospects for survival. Advanced colonies may be able to do their own genetic engineering after arrival, propagating particular genotypes in accord with needs and values. And there is the possibility of cyborgs, linking humans with machines in cybernetic organisms with enhanced toughness and capabilities. Such changes could lead to situations in which the colonists could not return to their originating biospheres.

In short, the coincidence of extraterrestrial colonization and advances in biotechnology could make the human design of human beings both more feasible and more desirable than it is now. Whatever options are pursued, the possible environments and biotechnological solutions are so varied that different futures seem likely for different parts of the expanded human species. Such divergences will increase the sense of difference between colonists and the Earthbound. Judging by the history of racism on this planet, we must expect that physical differences among human communities will be reinforced by prejudice and ideology.

Some colonies will respond to challenges better than others. Those that succeed, especially in other star/planet systems, may be destined, singly or collectively, to become new civilizations. Those that fail may range along a continuum from indefinite dependence on the originating society to extinction. But all will be affected, in varying degrees by pressures different from those that have influenced the evolution of human societies on Earth.

These factors lead to one general conclusion about the future of the human species if it colonizes our solar system and others beyond it: there will be growing divergences among the colonies, and between the colonies and Earthbound societies. That divergence will find expression in cultural forms, modes of social interaction, preferences for shaping the future, and eventually in biology. It also will find expression in a growing desire for independence from the Earth, its cultures, its economic, political, and military systems.

From the beginning of our planning for the expansion of the human sphere, we must recognize that extraterrestrial colonists will come to believe that they are different from Earth-bound humans. They will have different experiences, different dangers, different joys; they will find it annoying, frustrating, and eventually inevitable that the Earthbound do not understand. This sense of separation, and the deepening concern of the colonists with the success or failure of their own biospheres and societies, will lead to growing resistance to dependence on, or interference from, originating societies. Sooner or later, independence movements will become a fact of life for the expanded human species.

Originating societies may attempt to prevent the independence of their colonies through a variety of means, ranging from a threat to withdraw financing to the use of force. These methods may succeed within our own solar system, where communications and travel times are relatively short. But they probably will fail at interstellar distances; star colonies will be decades away, and must be self-sufficient from the beginning.

The prospect, then, is for a diversity of human societies spread throughout this solar system and a growing number of others, enjoying different degrees of independence. The eventual result may be a scattering of star-states separated by light years of time/distance, each remembering a common origin, but each so engrossed in its special concerns that the origin slips farther into the mists of legend with each generation. If interstellar travel remains a difficult, time-consuming, and costly project, the only links between human civilizations may be the great radio antennas that listen for voices from other stars.

The colonization of frontiers has affected the development and culture of many societies, including our own; so it will be with extraterrestrial colonization. There will be continuous feedback from the colonies to Earthbound societies; colonial experiences, perceptions, styles, values, ideas, and innovations will influence Earth cultures. The space economy will feed new inputs into the global economy, allowing it to grow beyond the limits that now concern us. The colonies may prove to be more vigorous, optimistic societies than those left behind, and may even produce leadership figures for the Earth. Eventually, the growth of human population and technological capability off the Earth may tilt the balance of influence in favor of the colonies, and Earth may decline in relative importance within the larger complex of human civilization. The planet might some day be governed or reinvigorated by remote descendants of the original colonists who left it to go into space. If warfare, biospheric disaster, or a terminal laboratory experiment on Earth should destroy its remaining human population, recolonization from space would vindicate the original colonization effort.

The most profound effect of extraterrestrial colonization may be on humanity's self-image. Colonizing this new frontier may stir hope among the Earth-bound, and create new perceptions of humanity's possible futures. Humans may regain the self-confidence that sometimes seems to be in decline in Western societies, creating an essential underpinning of a new human civilization. Humans may be freed of an impending sense of limitation on their future. They may see anew the virtues of diversification, of tolerance for different societies and cultures, and of intelligent growth. In new colonial societies, humans may regain a sense of community, of mutual dependence, and of social purpose.

The colonization of space and other worlds will so change human perceptions and abilities that future generations will look back on our time as the beginning of a new era, a new dimension of human existence. But humans will remain, in many ways, humans, and not idealized creatures out of science fiction. They will suffer from their limitations, their frailty, their lack of wisdom, and from the tension between individual and society. Humans beyond the Earth can no more escape the need to confront themselves, their needs, and their weaknesses than can humans here.

But we can improve their prospects by designing these new biospheres to be as hospitable as possible. We can strive to include adaptive variety as a factor in the selection of colonizing populations, both genotypically and culturally. We can recognize divergence before it leads to unnecessary conflict, and ease the transition to independence. We can, if we have a long enough perspective on species survival, seek an early crossing of two thresholds in extraterrestrial colonization:

1. Establishing the first self-sufficient colonies off the Earth, creating alternative, survivable biospheres, and alternative societies.
2. Human interstellar flight and colonization, drastically reducing the danger of terminal conflict within the human species, ensuring its diversification, and improving its long-term prospects for survival.

To summarize: sending humans to permanent habitations in space or on other worlds will change both the colonists and those who send them. These changes will grow in scale and importance as colonization proceeds outward and new generations are born off the Earth. The alien and often hostile environments surrounding extraterrestrial communities, and the human-designed artificial biospheres that will be necessary for human survival, will test human adaptive potential, creating new strains on individuals and societies. However, the experiences, perceptions, and capabilities of extraterrestrial societies also will open up new possibilities for individual and social evolution, and new scales of human existence and achievement, making us larger in every sense than we were before.

These changes in the human condition are just beginning. Our judgments about them must be speculative at this time. But it will not be long before social science is able to study humans in new environments, removed from the Earth. And social science skills will be needed in our designs for extraterrestrial biospheres. Eventually, whole alternate societies in exotic environments will allow comparisons with our Earthbound conclusions about the nature of humanity. And, someday, we may encounter an intelligent extraterrestrial species, requiring us to develop a science of intelligent beings in addition to a science of humanity.

LUNAR UTILIZATION ABSTRACTS PUBLISHED

Lunar Utilization, abstracts of papers presented at a special session of the 7th Annual Lunar Science Conference, 16 March 1976, is now available from the Lunar Science Institute. This special session on the utilization of lunar materials and expertise for large scale operations in space was organized by Dr. David R. Criswell (LSI). The 188-page volume, edited by Dr. Criswell, can be obtained by sending a check for $1.00 U.S., $6.00 foreign, to cover mailing costs, to Ms. Carolyn Watkins at the LSI, 3303 NASA Road No. 1, Houston, TX 77058.

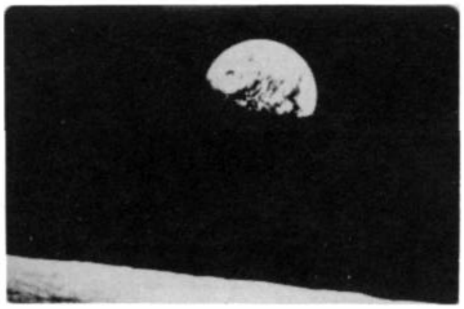
L5 SOCIETY

SLIDE SHOW

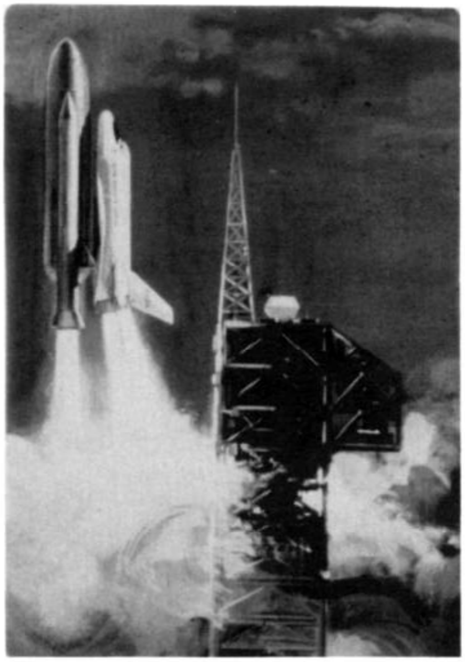
The following images are in four sections: INTRODUCTION TO THE L-5 CONCEPT (101-118), SPACE INDUSTRIALIZATION (201-228). SATELLITE SOLAR POWER STATIONS (301-312). and SPACE HABITATS (401-418). If you wish to order any of these images as slides or sets of slides, see the order form at the end of the slide show.

INTRODUCTION TO THE L-5 CONCEPT

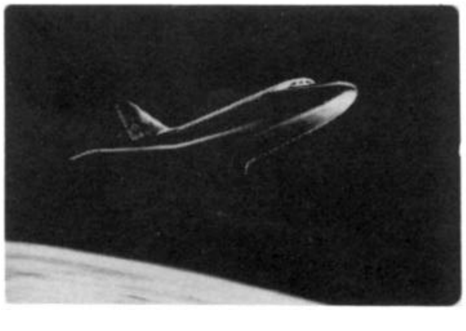
101 The Moon, source of most of the materials for space colonization.



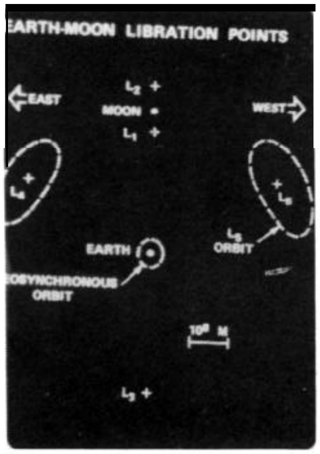
102 Apollo 8 view of the Earth seen from the Moon (NASA photo).



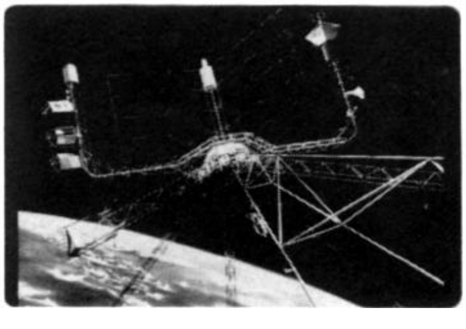
103 The space shuttle takes off from the Earth, carried by the lift vehicle.



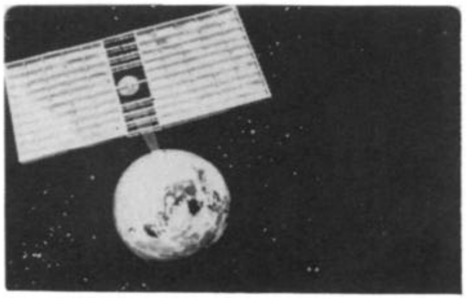
104 NASA space shuttle entering the atmosphere.



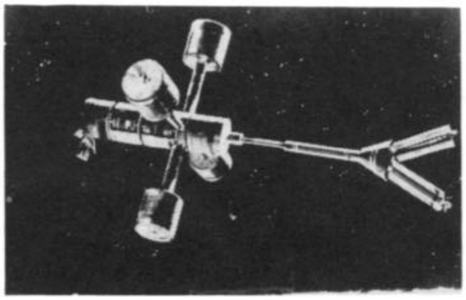
105 The geography of space, showing some points significant for space colonies.



106 Part of a power satellite under construction in low Earth orbit (Boeing).

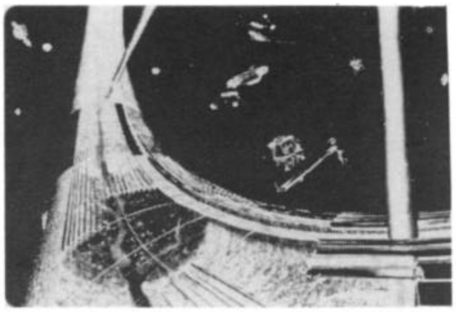


107 Power satellite of the photovoltaic type (Arthur D. Little).

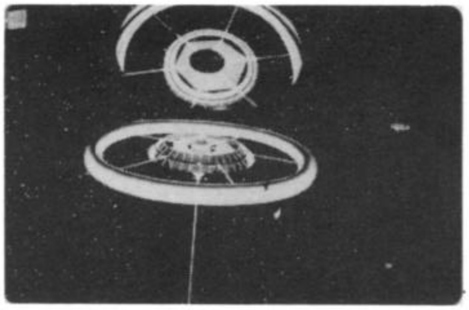


108 Space base "construction shack" for space industrialization.

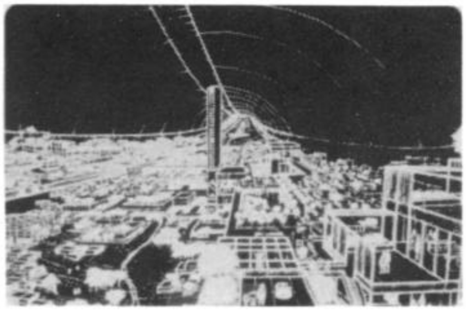
109 Space farm-interior of the space base "construction shack."



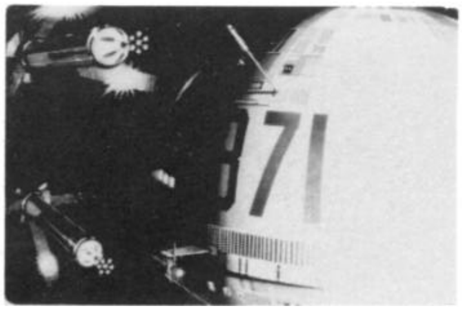
110 Construction in space of a space colony (toroid design).



111 A completed colony (toroid design by 1975 NASA/Ames Summer Study).

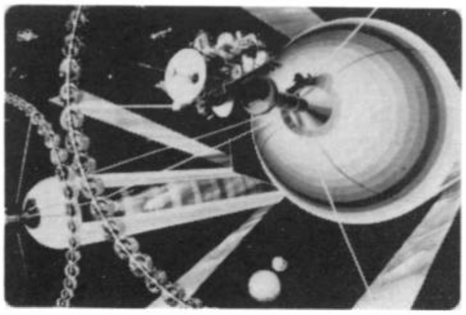


112 Interior of a colony (toroid design by 1975 NASA/Ames Summer Study).

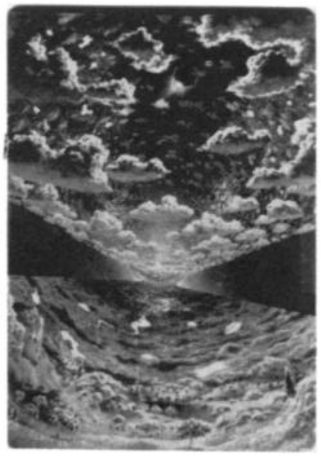


113 The spaceliner *Robert H. Goddard* brings in a new group of immigrants (Courtesy *Science Year).*

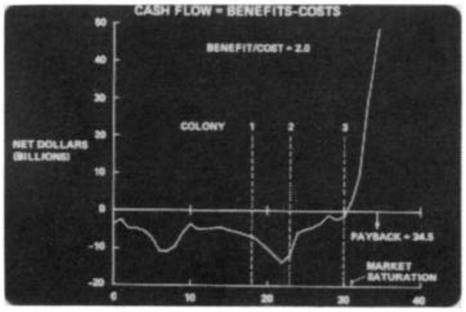
114 Interior design of a colony founded by a group of expatriate San Franciscans.



115 An advanced colony. Two cylinders in tandem, each with a four mile diameter and twenty mile length.



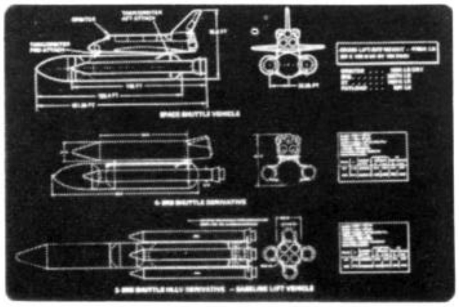
116 Solar eclipse in a colony. Cylinder interior is viewed along its axis.



117 Net revenue graphed over time (number of years from start of project).

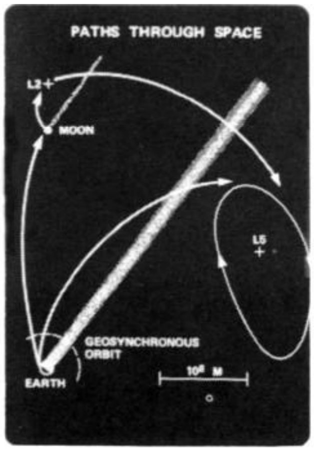
118 Humanity moves from the Earth to space in less than 100 years.

SPACE INDUSTRIALIZATION

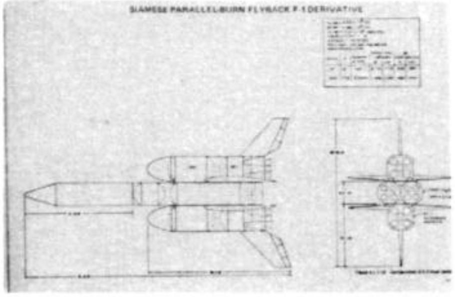


201 Schematic diagrams of the space shuttle, derivative, and lift vehicle.

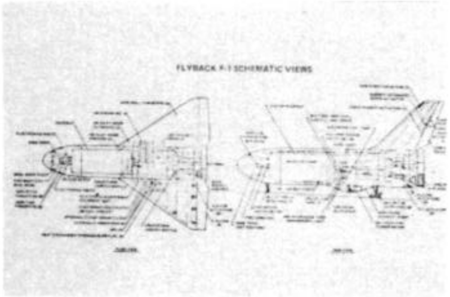
202 Space shuttle leaving the Earth via lift vehicle.



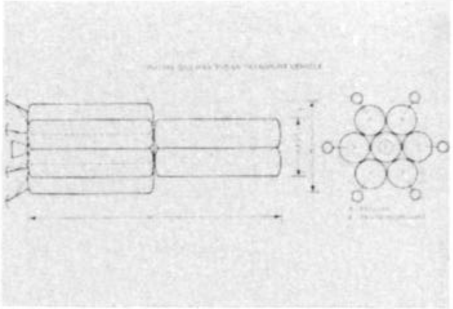
203 Paths through space from the Earth's surface (to scale).



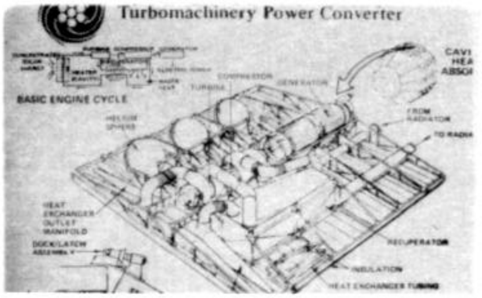
204 Design for carrying two reusable shuttles.



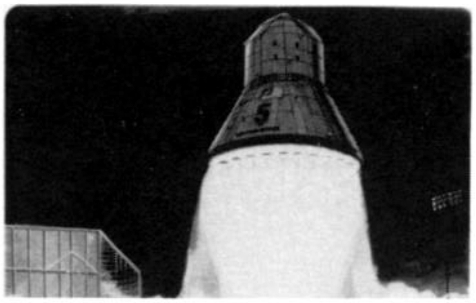
205 Design details of space shuttle (Flyback F-1).



206 One way lunar transport vehicle design.

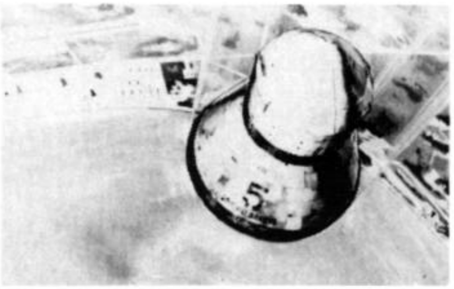


207 Design for Turbomachinery Power Converter.

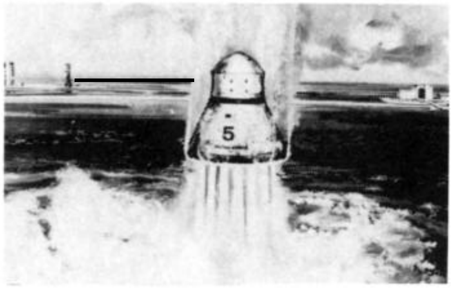


208 Heavy lift rocket takes Earth materials for construction to satellite solar power station (Boeing).

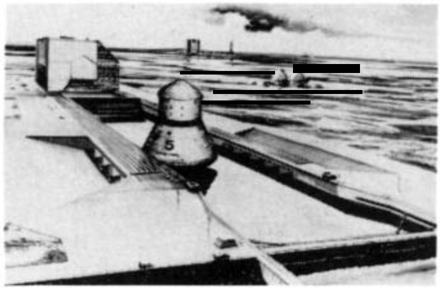
209 Cape Canaveral in the future, with landing basin and power receiving antenna (Boeing).



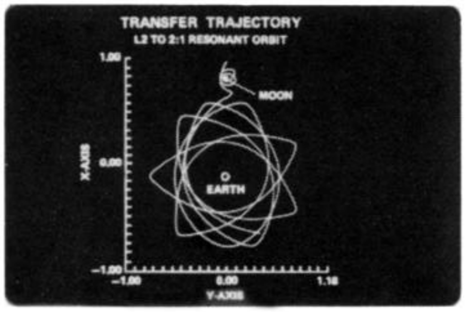
210 Heavy lift rocket re-entering and heading for landing basin (Boeing).



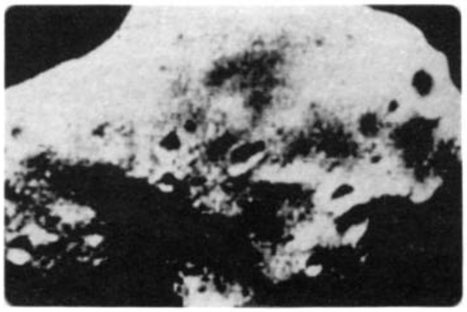
211 Heavy lift rocket landing after delivering Earth materials to construction site (Boeing).



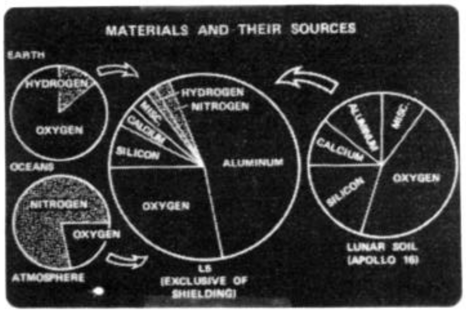
212 Heavy lift rocket docked and ready for next trip to construction site (Boeing).



213 A possible location for space habitats -- 2:1 resonant orbit (14 days).

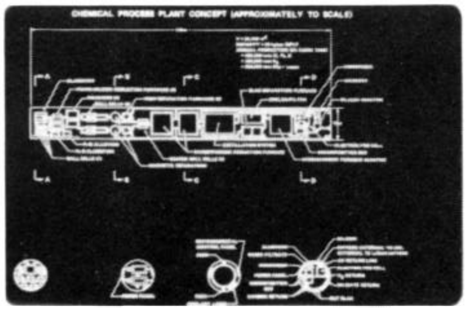


214 Phobos - asteroids are believed to look like this.

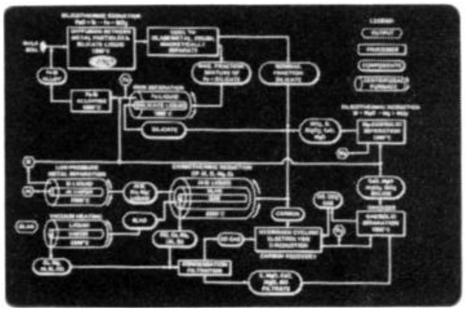


215 Summer study slide showing that almost all of the materials can come from the Moon.

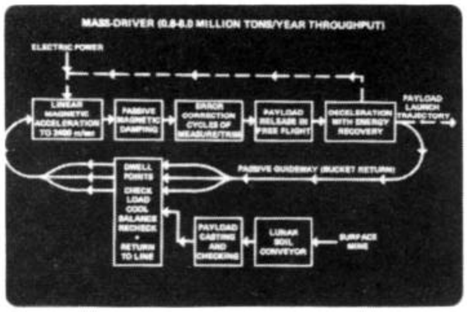
216 Lunar mine to obtain materials for construction in space (Field Enterprises).



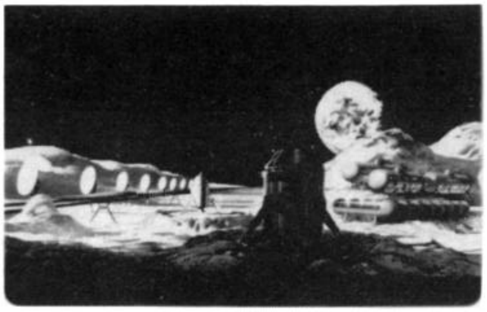
217 Mechanical layout of chemical processing plant.



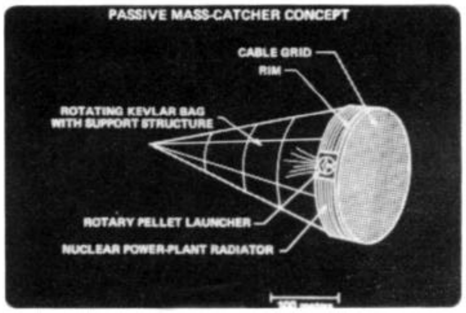
218 Flow diagram for chemical processing plant.


MASS-DRIVER (0.6-6.0 MILLION TONS/YEAR THROUGHPUT)
ELECTRIC POWER
LINEAR MAGNETIC ACCELERATION TO 2400 m/sec
PASSIVE MAGNETIC DAMPING
ERROR CORRECTION CYCLES OF MEASURE/TRIM
PAYLOAD RELEASE IN FREE FLIGHT
DECELERATION WITH ENERGY RECOVERY
PAYLOAD LAUNCH TRAJECTORY
PASSIVE GUIDEWAY (BUCKET RETURN)
DWELL POINTS
CHECK LOAD COOL BALANCE RECHECK + RETURN TO LINE
PAYLOAD CASTING AND CHECKING
LUNAR SOIL CONVEYOR
SURFACE MINE

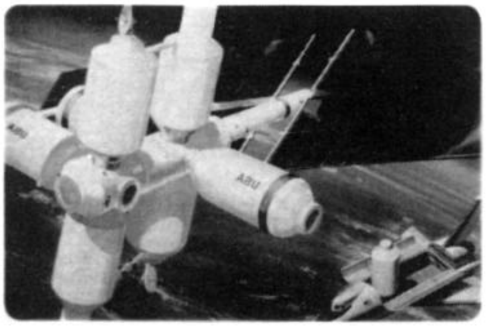
219 New version of the mass-driver (summer '76).



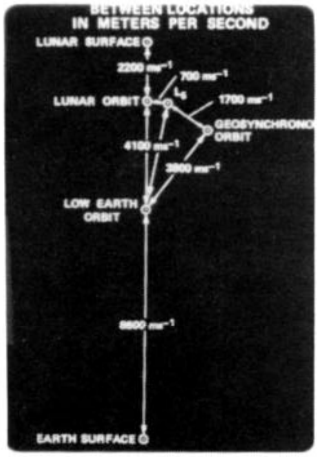
220 Lunar base with mass-driver launch track and habitations for crew (Field Enterprises).


PASSIVE MASS-CATCHER CONCEPT
CABLE GRID
RIM
ROTATING KEVLAR BAG WITH SUPPORT STRUCTURE
ROTARY PELLET LAUNCHER
NUCLEAR POWER-PLANT RADIATOR
100 meters

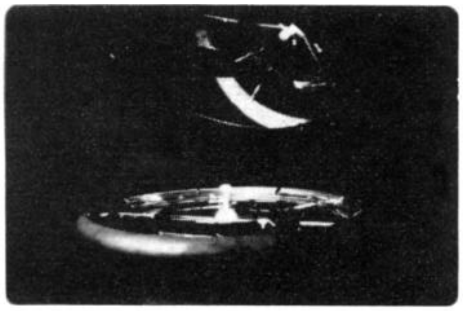
221 Early mass catcher design now superseded because of much greater accuracy by the TLA on the lunar surface.



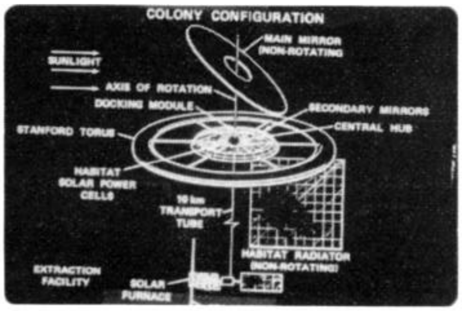
222 Space base used as habitat for construction crews.



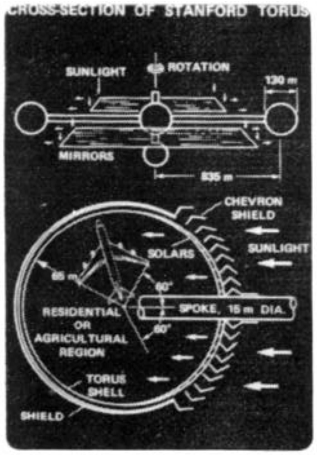
223 Distance between significant points in meters per second.



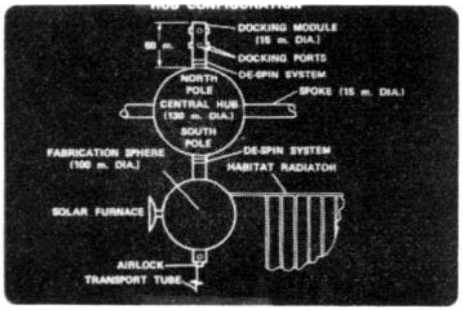
224 Model of the Stanford Torus design (NASA).



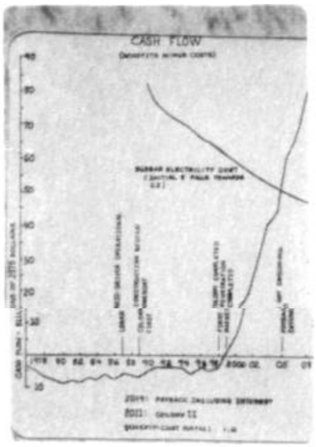
225 Details of the Stanford Torus design -- colony configuration.



226 Details of the Stanford Torus design -- cross-section.



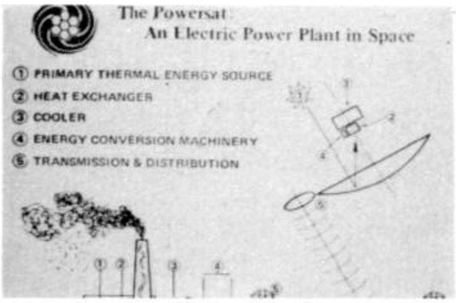
227 Details of the Stanford Torus design -- hub configuration.



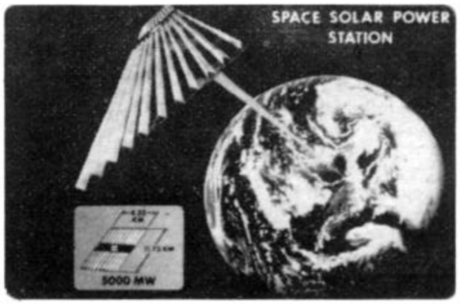
228 Results from an early economic study.

SATELLITE SOLAR POWER STATIONS

301 A view of the Middle East, present focus of energy discussions.

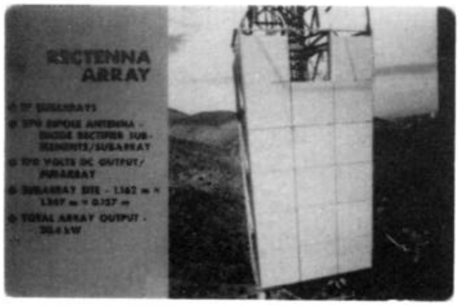

The Powersat:
An Electric Power Plant in Space
① PRIMARY THERMAL ENERGY SOURCE
② HEAT EXCHANGER
③ COOLER
④ ENERGY CONVERSION MACHINERY
⑤ TRANSMISSION & DISTRIBUTION

302 The Powersat: An Electric Power Plant in Space (Boeing design).



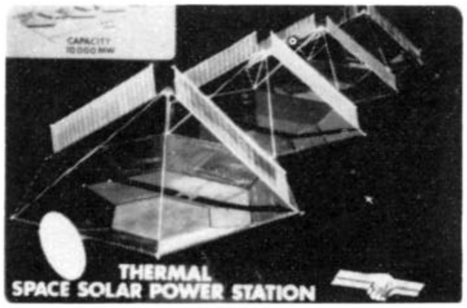
303 Photovoltaic type of solar power satellite with one km. diameter transmitter/antenna in center (Arthur D. Little design).

304 Microwave power transmission test (summer of 1975).

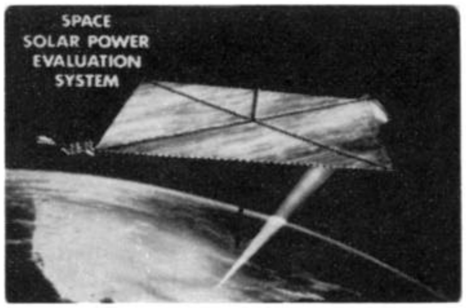


305 Microwave power transmission test (summer of 1975).

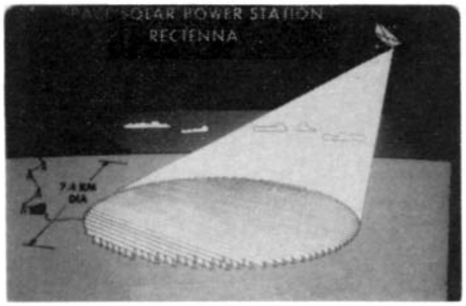
306 Power satellites in geosynchronous orbit as seen from Washington State (Boeing).



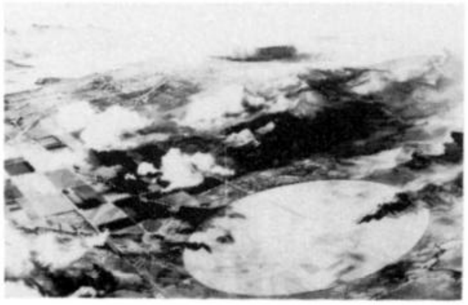
307 Photo-thermal type of solar power satellite, white disk is the transmitter/antenna (Boeing).



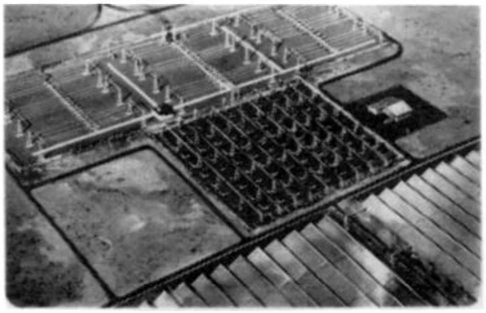
308 An early small test SPS built using the shuttle.



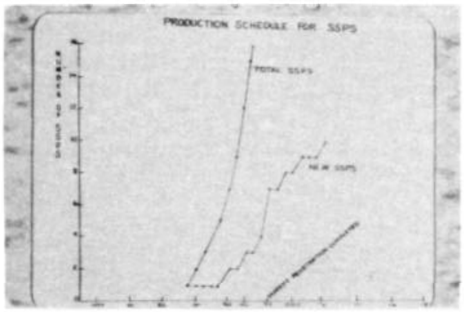
309 Rectenna configuration for receiving microwave transmission from SPS.



310 Rectenna array over farmland for receiving microwave transmission from SPS.

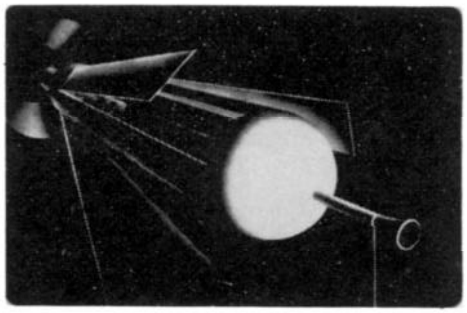


311 Inverters and standard power grid at the edge of the rectenna array over farmland.

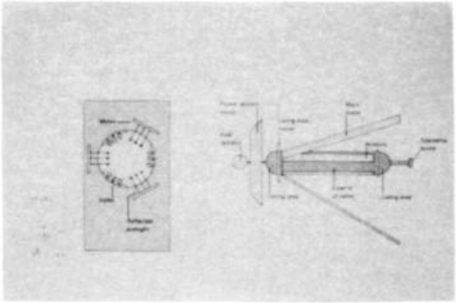


312 Production schedule for satellite solar power stations.

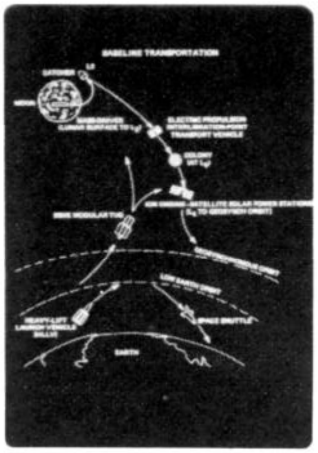
SPACE HABITATS



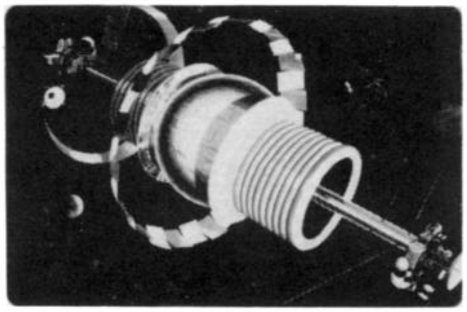
401 First painting of a space habitat -- four by twenty miles in size (cover of *Physics Today,* September 1974).



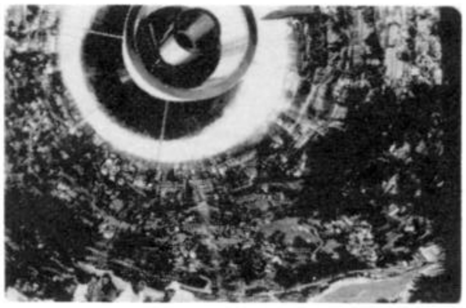
402 Diagram of Model 1 space habitat indicating living areas, valleys, and energy source.



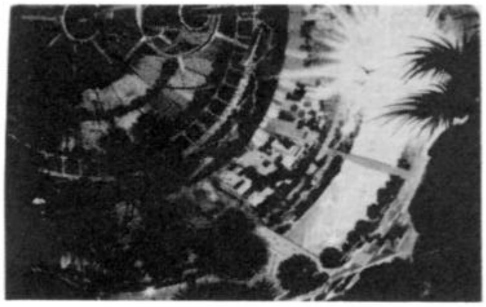
403 Baseline transportation diagram: Earth, Moon, colony at L-5.



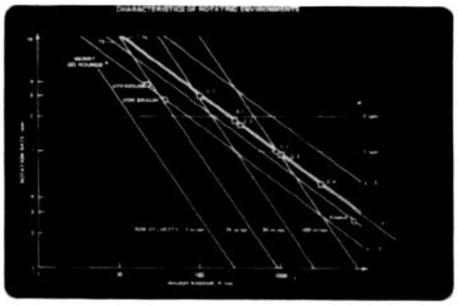
404 "Bernal Sphere" design for an early space habitat -- accommodating about 10,000 people.



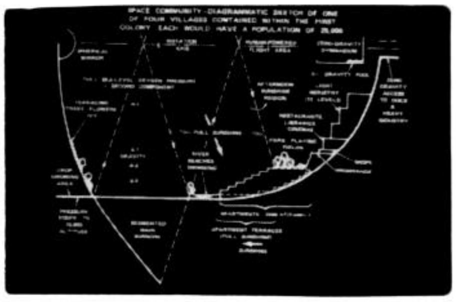
405 Interior of a "Bernal Sphere" space colony.



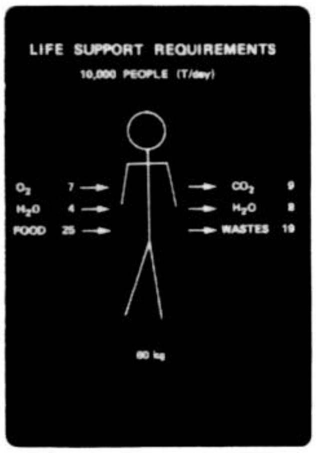
406 Detail of the interior of a space colony (Field Enterprises).


CHARACTERISTICS OF ROTATING ENVIRONMENTS

407 Design considerations for rotating space habitats.


SPACE COMMUNITY - DIAGRAMMATIC SKETCH OF ONE OF FOUR VILLAGES CONTAINED WITHIN THE FIRST COLONY EACH WOULD HAVE A POPULATION OF 25,000

408 Early design of space colony (May 1975), now outdated.


LIFE SUPPORT REQUIREMENTS

10,000 PEOPLE (T/day)

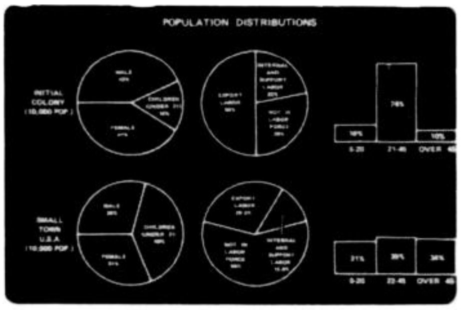
O_2 7 → → CO_2 9

H_2O 4 → → H_2O 8

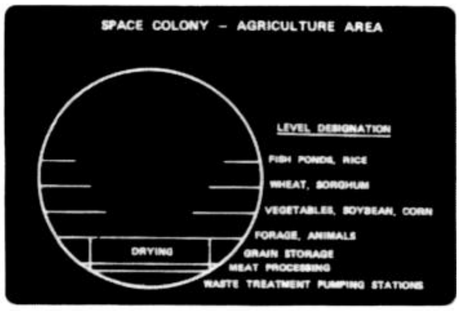
FOOD 25 → → WASTES 19

60 kg

409 Life support requirements, taken from the Stanford Torus study.


POPULATION DISTRIBUTIONS

410 Population distributions, taken from the Stanford Torus study.


SPACE COLONY – AGRICULTURE AREA

LEVEL DESIGNATION

FISH PONDS, RICE

WHEAT, SORGHUM

VEGETABLES, SOYBEAN, CORN

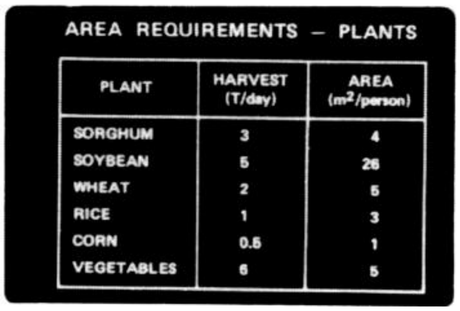
FORAGE, ANIMALS

GRAIN STORAGE

MEAT PROCESSING

WASTE TREATMENT PUMPING STATIONS

411 Cross-section of the agricultural area of the Stanford Torus design.


AREA REQUIREMENTS – PLANTS

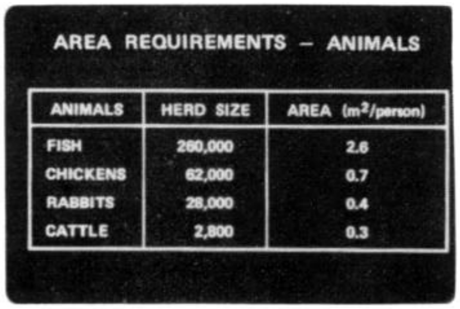
PLANT	HARVEST (T/day)	AREA (m^2/person)
SORGHUM	3	4
SOYBEAN	5	26
WHEAT	2	5
RICE	1	3
CORN	0.5	1
VEGETABLES	6	5

412 Area requirements for plants, taken from 1975 NASA/Ames summer study.

A NOTE ABOUT THE SLIDES

We recommend the slides be used for lectures or other presentations explaining the L-5 concept and the possibilities of space industrialization and settlement.

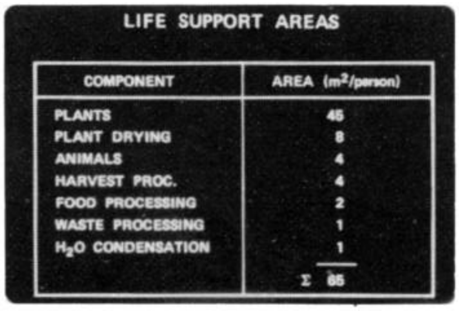
We wish to add more slides to the catalog in the future. We would welcome receiving slides from members who would like to have them made available to others through the L-5 Society.



AREA REQUIREMENTS – ANIMALS

ANIMALS	HERD SIZE	AREA (m^2/person)
FISH	260,000	2.6
CHICKENS	62,000	0.7
RABBITS	28,000	0.4
CATTLE	2,800	0.3

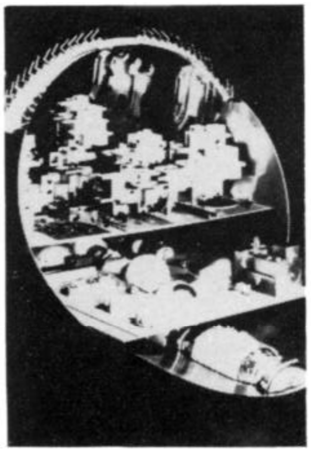
413 Area requirements for animals, taken from 1975 NASA/Ames summer study.



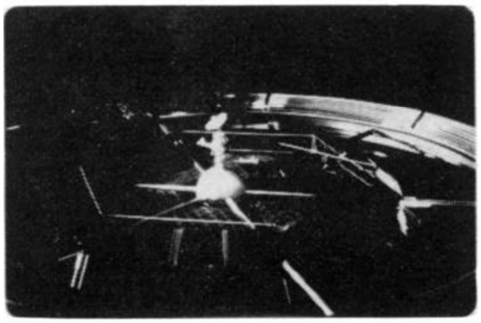
LIFE SUPPORT AREAS

COMPONENT	AREA (m^2/person)
PLANTS	45
PLANT DRYING	8
ANIMALS	4
HARVEST PROC.	4
FOOD PROCESSING	2
WASTE PROCESSING	1
H_2O CONDENSATION	1
	Σ 65

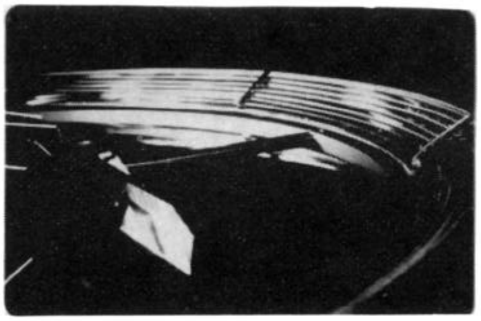
414 Life support areas, taken from 1975 NASA/Ames summer study.



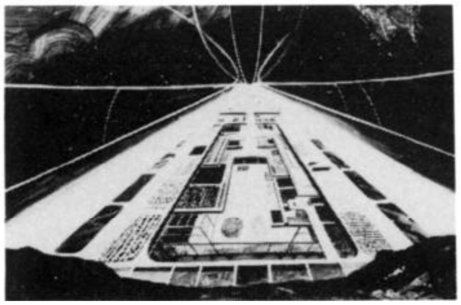
415 Cross-section of a model of the Stanford Torus, showing habitat, and other areas.



416 The Stanford Torus: a wheel-shaped habitat with spokes rotates within a tire of cosmic ray shielding.



417 Closeup of Stanford Torus exterior.



418 Agricultural area of the Stanford Torus, situated between two parks.

THE L-5 SOCIETY SLIDE SHOW
Order Form

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- SPACE INDUSTRIALIZATION (28) 0201-228
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STUDY TOPICS LIST (continued from page 1)

    - A) Effects of Partial G on Bone Calcium Loss, etc.
    - B) Effects of Rotation in Range Appropriate to Small Structures (2-4 RPM)
- Experimental Studies (resulting in Concept verification or new scientific knowledge);
  - 1) Mass-Driver (unique opportunity Kolm/O'Neill/MIT only during 9/76-5/77)
  - 2) Model Lunar Soil (needed for all processing experiments)
  - 3) Ionospheric Effects of Microwaves (cooperation with ERDA LASL proposal 12/76)

II. Material Resources

- Lunar Soils Modeling (simulation) :
  - (less difficult)
  - Chemical Equivalence
  - Particle Size Distribution
  - Trace Elements
  - Volatiles
  - Radiation History
    - (last 2 affect chemical leaching)
- Needed for experiments on :
  - Chemical Processing
  - Payload Formation
  - Agricultural Methods and Yields
  - Direct Formation of Low-Density Blocks/Structures
- Develop Computer-Correlative Inventory for Lunar Surface :
  - Topography Suitable for Particular Requirements :
    - Launching- Downrange Correction
    - Solar Energy Utilization
    - Communications
  - Regolith Depth
  - Chemical Composition from
    - Apollo
    - "Prospector" (Lunar Polar Orbiter)
    - Geological Prediction
    - Samplers
  - Proximity of Permanently-Shadowed Areas
  - Velocity Intervals for Soft-Landing
  - Proximity of Boundaries Between Differing Mineralogical Areas
    - Needed for:
    - Chemical Processing Studies
    - Study of Materials Local-Transport methods
    - Study of Materials Launching Methods
    - Evaluation of Excavation Techniques
- Develop Computer-Correlative Inventory for Asteroids :
  - Minerology
  - Mass
  - Orbital Elements and Velocity Interval to Reach
  - Launch Windows
  - Escape Velocity
  - Rotation Rate
- Other Research :
  - Extend Theoretical Studies on Lunar High Latitude Volatiles
  - Integrate Lunar-Polar-Orbiter ("Prospector") Launch Schedule into Critical-Path Analyses
  - Study Slope Stabilization
  - Study Deep Drilling Techniques
  - Study Lunar Soil Sampler Missions
  - Intensify Search for Asteroids of Low Velocity Interval (Apollo-Amor Class). Correlate with Spectral Analysis
  - Study Dedicated Schmidt Telescope (Ground) + (Space)
  - Intensify Study of Asteroidal Flyby Missions
  - Study Asteroidal Sampler Missions

III. Transport

- Study Conventional Vehicles and Methods :
  - Shuttle-Derived HLV
  - Shuttle/OTV Passenger Compartment Module
  - OTV (Orbiter Transfer Vehicle)
  - LTV (Transfer Vehicle Orbit to/from Lunar Surface)
  - Tanker or Tank Module for Early Use of Lunar Oxygen
  - Fuel Depots and Warehousing
  - Orbital Refuelling Techniques
  - Shuttle Uprating
- Lunar Materials Launch/Guidance :
  - Methods :
    - Mass-Driver
    - Gas-Gun
    - Encourage Search for Other Alternatives
  - Evaluation Criteria :
    - Stress
    - Wear
    - Reliability
    - Maintainability
    - Repairability
    - Fail-Safe Design
    - Uprating Capability
    - Efficiency
    - Accuracy
  - Related Studies :
    - Orbital Mechanics Moon / Space
    - Materials Collection in High Orbit
    - Raw Materials Preparation/Packaging
    - Canisters for Special Payloads:
      - Liquid Oxygen
      - Stored Information
      - Electronics
      - Medical Supplies
      - Silicon Wafers
- High Specific-Impulse Engines :
  - Methods :
    - Mass-Driver
    - Ion Thruster
    - Solar Sails
    - Micropellet Electrostatic Thrusters
    - Other
  - Evaluate :
    - Thrust Capabilities
    - Specific Impulse Capabilities
    - Efficiency
    - Thrust/Mass Ratio
    - Utilization of Non-Terrestrial Reaction

    - Size Scaling
- Environmental Effects Studies :
  - Consider :
    - Lunar and Geosynchronous Environment
    - Van Allen Belts
    - Ionization Layers
    - Ozone Layer
    - Troposphere
    - Land and Water
- In Environmental Effects Studies, Evaluate vs. Traffic :
  - SRB Effects
  - Liquid-Fuel Rocket Effects
  - Mass-Driver Engine Reaction Mass Choices :
    - Liquid Oxygen
    - Powder
    - Pellets
    - Slugs
  - Ion-Thruster Reaction Mass Alternatives :
    - Mercury
    - Cesium
    - Nitrogen
    - Other
  - Orbits, Impacts, Hazards of Uncollected Lunar Material
  - Atmospheric Entry Effects (Nitrogen Dioxide Formation, etc.)
- Other Transport Studies :
  - Lunar Surface Material Conveyors
  - Lunar Surface Transport Systems (with or without crew) :
    - Magnetic Levitation
    - Wheeled
    - Other

IV. Processing
(* indicates Shuttle)

- Oxygen Processors
- Oxygen Liquefaction*
- Dry Bulk Separation*
- Process Study Evaluation
  - Yields (for Carbothermic Silicon Reduction + All Other Processes)
  - Reaction Rates
  - Equipment Inventory
  - Throughput/Equipment-Mass Ratios
  - Suitability for Automation and/or Process Flow
  - Utilization of Zero-Gravity or Centrifugation*
  - Utilization of Solar Energy*
  - Utilization of High Vacuum
  - Non-Solar Energy Needs
- Solar Furnace Design*
- Search for New Process Techniques*
- Use of Volatiles (Sulfur, Nitrogen, Hydrogen, Helium)
- Magnetic Separation
- Eddy-Current Separation
- Containerless Processing
- Concept Studies of Chemical Engineering Unit Operations

V. Industrial Operations

- Handling Machinery
- Rolling
- Milling
- Blooming
- Casting
- Welding
- Hot/Cold Working
- Extrusion
- Coating Techniques (Thin Film)
- Vapor Deposition (Structural Thicknesses)
- Alloying
- Wire-Spinning into Cables
- Foamed Metals
- Foamed Ceramics
- Structural Glass
- Optical Glass
- Insulator Manufacture
- Powder Technology
- Analogs to Cement (Sulfur-based, etc.)
- Composites not Requiring C, N, H
- Solar-Cell Manufacture
- Industrial Mass Spectrometry
- Sealants
- Catalytic Effects of Dispersed Fine-Grain Lunar Soils
- Search for Undiscovered Manufacturing Techniques
- Modern Spacesuits
- Enclosed vs. Vacuum Environments
- Manufacturing Machinery Evaluation/Design vs.
  - Elements Required
  - Mass Required
    - High Complexity, Low Mass (from Earth)
    - Low Complexity, High Mass (Yokes, Frames, Bases)
  - Static/Dynamic Loads
  - Vibration
  - Fatigue
  - Zero Gravity or Rotation
  - Materials/Assemblies Traffic
  - Quality Control
  - Personnel Shielding
  - Repair by Humans vs. Automated/Telemetered Repair

VI. Structures

- Categories : RP; RN; NP; NN
  - (R = Rotating; P = Pressurized)
- Types
  - Plate Structures
  - Truss Structures
  - Cable-Wound Structures
  - Vapor-Deposited Structures
- Special Components
  - Window Areas
  - Bearings
  - Airlocks/Seals
  - Radiators
  - Heat Pumps
  - Blowers

  - Heat Pipes
  - Structure
  - Light Concentration
- Human-Rated
  - Lunar Bases
    - Ground Properties
    - Civil Engineering
    - Energy Utilization
    - Personnel Shielding
  - Space Habitats, Deep-Space Vessels,
    - Orbital Laboratories
    - Geometries
    - Energy Utilization
    - Atmospheric Dynamics/Weather
    - Personnel Shielding
    - Sound Propogation
    - Norse Control
- Universal Considerations
  - Structure Design Calculability
  - Mass Required
  - Atomic Elements Calculability
  - Optimization for NonTerrestrial Materials
  - Oscillations and Damping
  - Nutation and Precession
  - Fatigue Life
  - Fail-Safe Design
  - Safety in Use
  - Evacuation/Rescue
  - Inspection
  - Maintainability
  - Repairability
  - Productivity to Build

VII. Human Parameters

- Biological Parameter Tolerance Distributions (Percentages Accepting) All as Functions of
  - Age
  - Sex
  - Pregnancy Condition
  - Time of Exposure
  - Cycle of Exposure
  - Previous Personal History
- Quantifiable Variables :
  - Oxygen Pressure
  - Nitrogen Pressure
  - Trace-Gas Pressures
  - Humidity
  - Toxic Substances
  - Water
  - Food
  - Temperature
  - Gravity/Acceleration
  - Rotation Rate
  - Diurnal Cycles/Circadian Rhythms
  - Sunlight Spectrum/Intensity
  - Radiation (Minimum Ionizing, Heavily Ionizing, Gamma)
  - Vibration
  - Shock
  - Noise
  - Sound Propagation
  - Magnetic Fields
  - Microwaves
- Variables Less Easily Quantified :
  - Personal Space/Privacy
  - Variety/Availability of Clothing
  - Variety/Availability of Foods and Beverages
  - Isolation
  - Sexual Needs
  - Opportunities for Recreation/Exercise/Creativity
  - Cultural Needs (Books, Tapes, Radio/TV, Cultural Events)
  - Opportunities/Ease of Communication
    - Other Local Points
    - Earth
  - Sense of Personal Value/Independence vs. Exploitation
  - Overwork
  - Psychology of Personal Relationships
  - Sense of Security from Personal Threat (Disaster-Security)
  - Societal Desires (Community Size, etc.)
  - Legal Desires
  - Economic Desires
  - Opportunities for Travel
    - Other Human Locations in Space
    - Earth
  - Religion
- All Affecting :
  - Habitat Overall Design
  - Internal Design
  - Landscaping
  - Decorative Art
  - Personnel Transport Design
  - Communications Systems Design
  - Societal/Legal/Economic Structure
  - Personnel Selection Criteria
  - Personnel Tasting
  - Personnel Equipment (e.g., Voice Amplifiers)

VIII. Ecosystems

- Components : (Crops for Consumption; Seed Crops)
  - Food Plants
  - Decorative Plants/Trees
  - Animals
  - Birds
  - Scavengers
  - Bacteria/Viruses
  - Machinery
  - Humans
    1) As Ecological Components
    2) For Human Intervention to Maintain Ecological Stability or Force Change
- Main Parameters
  - Soil Type/Depth
  - Water Balance
  - Nitrogen Balance
  - Oxygen Balance
  - CO_2 Balance
  - Trace Element Balance
  - Sunlight Spectra and Angles
  - Diurnal/Circadian Cycles
  - Gravity
  - Rotation
  - Radiation
  - Seeding and Harvesting Techniques
  - Atmospheric Flow Patterns
- All Affecting (1) Utilization of Non-Terrestrial Materials; (2) Need for Materials from Earth
  - Main Habitat Design
  - Agricultural Area Design
  - Special Agricultural Atmospheres and Circulation Systems
  - Waste Recycling Systems
  - Plant/Animals/Bird/Scavenger/Bacteria Selection Criteria
  - Ecological Stability Studies (Mathematical Modeling)
  - Food Marketing/Distribution Techniques
  - Human Tolerance Selection Criteria and Skills Selection
  - Scaling With Unit Size
  - Isolation/Monitoring/Inspection
  - Productivity
- Special Ecosystem Challenges :
  - Lunar Bases
  - Orbital Stations
  - Local-Space Vessels
  - Deep-Space Vessels

IX. Energy

- Electricity Generation/Transmission Methods: (Component Development; Systems Integration)
  - Solar Cells
  - Turbogenerators
  - Other?
  - Microwave Generation and Beaming
  - Microwave Rectification
  - Conductor Transmission Lines
    - (On Lunar Surface, or Near/In Space Habitats, etc.)
  - Laser and Other Energy Transmission Methods
  - Nuclear Energy Generation
- Direct Thermal Uses :
  - Solar Furnace Designs
  - Control of Spectrum by Windows and Mirrors
- Direct Utilization of Solar Spectrum :
  - Photoionization as Part of Chemical Processes
- Special Energy Challenges :
  - SSPS
  - Lunar Electric and Thermal Power Sources
  - High-Efficiency DC to Audio-Frequency Power Transfer
  - Synthetic Fuels Production
  - For Terrestrial Applications
  - For use in Space
  - Deep-Space Vessels
  - Electrically-Powered Space-Probes
  - Synthetic Fuels Production
    - For Terrestrial Applications
    - For Use in Space
  - Deep-Space Vessels
  - Electrically-Powered Space-Probes
- Special Research Issues :
  - Environmental Effects of Microwaves :
    - Ionospheric
    - Atmospheric/Weather (Absorption in Rainstorms, etc.)
    - Human Tolerances
    - Effects on Aircraft
    - Effects on Birds
  - Testing of Transmission Systems :
    - On Earth, Between Mountains (~100 km)
    - Earth to/from Space
    - Up/Down Differences in Microwave Transmission Tests
    - Optimization of SSPS Design for for Utilization of Lunar-Available Materials

X. Products

- Quantifiable :
  - Satellite Solar Power Stations
  - Solar Power for Use in Space
  - Space Engines (High Thrust, High Specific Impulse)
  - Reaction Mass for Engines in Space (Oxygen, Rock Dust, etc.)
  - Components of Main Regenerative Loop :
    - Lunar Materials Launchers
    - Solar Power Systems for Lunar Surface
    - Chemical Processing Equipment
    - Manufacturing Equipment
    - Workforce Habitats
  - Large-Aperture Radio-Telescope Arrays
  - Specialized SETI Antennas
  - Large-Diameter Optical Telescope Arrays (Synthetic Optics)
  - Communications and Observation Satellites
  - Space Laboratories
  - Unmanned Space Probes
  - Orbital Laboratories for Location Around Other Planets
  - Landers for Other Planets
  - Space Vessels for Asteroidal and Other-Planet Research
- Quantifiable but Not Itemized Products :
  - Removal of Earthbound Limits to Growth
  - Environmental Conservation and Protection
  - Productivity (the Most Important Quantifiable Product)
- Less-Quantifiable Products and Added Values :
  1) Satisfaction of Human Needs for Hope and New Frontiers.
  2) Satisfaction of National Needs for a Sense of Civilization-Leadership and of Place in History
  3) De-Escalation of Conflict Through Partial Replacement of International Military Rivalry by Joint Response to a Common Nonmilitary Extraterrestrial Challenge

XI. Value Relationships

- Identify Ordering Parameters ($, $/kg, Throughput/Installed Mass, Lunar/Terrestrial Materials Utilization, Doubling Times, etc.)
- Cross-Correlate Research Items with Priorities on :
  - Probable Location on Critical Path
  - Adequate Starting-Information to Initiate Research Immediately
  - No Long-Lead-Time Prior Technology Development Required
  - Fortunate Coincidences of Research Personnel, Facilities, Time and Place (Serendipity Factor)
  - Likelihood of Large Return of Information or Technological Risk-Reduction from

Modest Research Investment
- Likelihood of Synergism with Research Applicable Near-Term on Earth
- Commonality to Any Plausible Long-Range Industrialization Effort
- Chance of Later Cooperation with Other Agencies or Industry
- Probable Existence and Availability of Competent Researchers for the Item
- Research Building on and Reinforcing the Shuttle Program
- Research Leading Naturally to Shuttle Experiments and Experiments at the Space-Industrialization Complex

General Needs :
- Develop Economic Analysis Methods Applicable to the Use of Non-Terrestrial Materials Sources
- Develop Economic/Research Status/Critical Path Analyzing Techniques for Space Manufacturing Program Permitting Rapid Correction and Updating
- Explore Historical Analogs (Westward Movement, Mining, Oil Exploration, etc.) for Lessons on Successes/Failures
- Reinforce and Build on Synergistic Education-Avenues Originating Both in and outside of Agency (Articles, Books, Radio and Television Interviews/ Panel Discussions, Documentaries, Professional Society Meetings)
- Explore Investment Scenarios and Probabilities:
  - U.S. Private
  - U.S. Public
  - Combined
  - Multinational
  - Non-U.S. (Drooped-Ball Effect)
- Quantify Non-Monetary Products and Values (Environmental, etc.).

STUDENTS LEARN LESSON IN SPACE ECONOMICS

From FASST Tracks

With the blessings of NASA being bestowed upon a high school and college level student payload program for the Space Shuttle, the first forms of the concept are taking shape from the NASA paperwork and rearing, along with this reality, the ugly head of the dollar mark.

In the November 8 issue of *Aviation Week and Space Technology* magazine the student Shuttle program was likened to an “orbital counterpart of the scheduled airline youth fare.” Payloads which are self contained and less than 200 lbs. will be handled on a “space available basis,” and, according to NASA, will be flown for a “nominal amount”-between $3,000 to $10,000 in 1975 dollars. Additional fees will be negotiated if orbiter or crew support is needed.

FASST has learned that one high school student payload program, with a price tag of over one-half million dollars, has been turned down. The idea was generated internally at NASA, but the “powers-that-be” determined that the program was too expensive. That proposal is now being scaled down to an amount which should be more palatable to NASA budget watchers. The question that should now be raised is: How meaningful can a cheap student payload program be?

It is obvious that students can’t be expected to pay thousands of dollars to fly an experiment in space, and from the NASA viewpoint money is also tight. Most of the Shuttle program officers are very supportive of student involvement in the Space Shuttle, however, they quickly follow-up their show of enthusiasm with, “but I’ve got no money here!” It appears that new sources of funds will be needed to keep a student space experiment program alive and well.

FLASH!
O’NEILL LEAVES FOR SAUDI ARABIA

Gerard K. O’Neill, space settlement proponent and author of *The High Frontier,* has just left for Saudi Arabia to give a lecture at the invitation of Aramco and the Saudi Arabian government.

His lecture, purely informational, will be the second of three lectures: the first was by Clark Kerr, former president of U.C. Berkeley, and the last will be by the president of the American Association for the Advancement of Science.

O’Neill informed the *L-5 News,* “There is no plan for and no reason for any expectation that the Saudis would be interested in putting up money toward the High Frontier.” Intermediate technology is the present focus for developing the country, according to O’Neill.

SPACE HABITAT STUDIES

The University of Illinois at Urbana-Champaign is offering a course this spring entitled: *Extraterrestrial communities: human considerations in design.* Psychological effects of various macrogeometry: large vista to avoid theatre-stage artificiality and solipsism syndrome; visibility of plants and animals which grow, and are independent from predictability; existence of “other towns beyond horizon” (in Torus). Two principles of heterogenization: localization; and interweaving. Four different principles of community design: homogenistic; individual insulation (privacy, self-sufficiency, uncoordinated random heterogeneity; hemostatic heterogenism (static harmony of diversity); morphogenetic heterogenism (interactions which generate heterogeneity, symbiotization, new elements, new patterns).

LUNA 24 SAMPLES INSPECTED BY U. S. LUNAR SCIENTISTS

Three U.S. lunar scientists, Dr. Michael B. Duke, NASA/Johnson Space Center; Dr. G. J. Wasserburg, California Institute of Technology; and Dr. Charles H. Simonds, Lunar Science Institute, visited Moscow on December 13-15 to examine lunar materials returned by the Luna 24 mission last August and to arrange for the transmission of samples for study by U.S. investigators. Luna 24 returned a 2 meter long, 8 millimeter diameter core from southeastern Mare Crisium, which has not been sampled previously by U.S. or Soviet missions. The site may contain material from nearby highlands and material from the ray crater Giordano Bruno some 1200 km away.

A Soviet-American space cooperation agreement provides for the exchange of samples from each of the lunar returns. The U.S. has provided 3 grams of sample from each of the six Apollo missions; the Russians have reciprocated with 3 grams of Luna 16 and 2 grams of Luna 20 samples, plus two small fragments of Luna 20 rock provided separately. Considering the fact that the Russian return has been 100 and 50 grams, respectively, for Luna 16 and 20, their cooperation in this exchange has been exceptional.

It is hoped that the samples will be transmitted to Houston to be available for distribution in the Spring of 1977.

SETI: Knocking at Heaven’s Door?

The Jet Propulsion Laboratory in Pasadena, California has announced that a search for extraterrestrial intelligence will get underway in October of 1978. At that time, scientists will begin to scan the heavens using a new signal processing technique that analyzes millions of frequency channels, simultaneously, in search of extraterrestrial civilizations.

Designed and developed in cooperation with the National Aeronautics and Space Administration’s Ames Research Center, which is located near San Francisco, the JPL Search for Extraterrestrial Intelligence (SETI) program is described as a “modest” but serious beginning. This initial step, using existing Earth-based radio telescopes, may lead, in time, to a SETI program involving construction of large antennas in space or, perhaps, on the Moon-away from radio interference from the planet Earth.

The announcement comes in the wake of an appeal from Nobel Laureate Sir Martin Ryle, a prominent astronomer from Great Britain, to refrain from making known the existence of intelligent life on the planet Earth, for fear that we could be invaded by hostile beings.

Sir Martin has taken his plea that radio astronomers should not beam out powerful signals to distant stars and galaxies to the International Astronomical Union and the American Astronomical Society. SETI scientists argue that the emphasis of their programs is on listening, with no thought, at this time, of transmitting. However, Sir Martin points out that such has not been the case as powerful radio signals have already been sent from the Arecibo Radio Telescope in Puerto Rico, and from a project designed to map the planets with strong radar pulses.

Inside the L-5 Society

L-5 DIRECTOR WINS GODDARD AWARD

The National Space Club in Washington has announced the name of the winner of its annual Robert H. Goddard Historical Essay Contest Competition for 1976. He is James E. Oberg, 32, an aerospace engineer at NASA‘s Lyndon B. Johnson Space Center in Houston, Texas.

The annual contest is devoted to encouraging research into historical questions in the development of rocketry, astronautics, and space exploration. Entries are solicited by November 1 of each year, with the judging to be completed by the following January. A distinguished panel of space experts from NASA, the Smithsonian institute, the Library of Congress, and the university community evaluates all of the entries without knowledge of the identity of the authors. Only when the winner is selected is a sealed envelope opened which contains the author’s name.

A certificate and a $500 cash award are presented to the winner at the annual Robert Goddard Memorial Dinner in Washington which is customarily held each April. Numerous other awards and scholarships are presented to other winners in different competitions.

The subject of Oberg’s winning historical paper is “Korolev, Khrushchev, and the Sputnik.” It deals with the behind-the-scenes political maneuvering in Russia which led to the Kremlin decision to proceed with the launching of the first Sputnik in 1957. Oberg drew on numerous Soviet, American, and West European sources, including Khrushchev’s memoirs, official Soviet biographies of top Russian space engineer Sergey Korolev, interviews, letters, defectors’ reports in English, Russian, and Ukrainian, and other obscure but vital leads.

Oberg, an Air Force Captain detailed to NASA for the Space Shuttle program, is a computer software analyst in the Spacecraft Software Division, where he prepares estimates for on-board software support for payloads. He has been at NASA since July 1975, having previously served at Kirkland AFB in New Mexico and as an instructor at the Department of Defense Computer Institute in Washington. He has two graduate degrees in astrodynamics and in computing sciences. He and his wife live in Alta Loma in rural Galveston County.

Besides his Air Force and NASA duties, Oberg is a free-lance science and space writer/lecturer. He is Associate Editor of *Space World* magazine and is a Contributing Editor to *Astronomy* magazine. His articles frequently appear in other journals such as *Science Digest, Spaceflight, Technology Review, Sky and Telescope, Aerospace Historian, Flight international, Analog* and New *Engineer.* He often lectures on space science and space colonization and is a member of the Board of Directors of the L-5 Society.

L-5 SOCIETY FINANCIAL INFORMATION

income and expenditure figures for the first and second quarters of the current fiscal year (beginning July 1, 1976) follow:

Income	**1st Quarter**	**2nd Quarter**
Memberships	$ 2,490	$ 4,356
Sales	868	2,627
Donations: O’Boyle	5,500	3,566
other	61	248
Income Totals	8,919	10,797
Expenditures		
Management Services	1,819	3,454
Printing & Copying	1,705	3,673
Conferences	752	1,013
Telephone	765	511
Postage & Shipping	697	765
Publications & Slides	472	1,268
Office Supplies & Expenses	51	395
Miscellaneous	294	191
Expenditure Totals	6,556	11,270

The expanded nature of current Society activities, in particular the improved quality of the newsletter, has been made possible by the generosity of William B. O’Boyle, of New York.

However, it is necessary for the Society to operate from a broad base, and Bill’s period of funding is now over. Current income from memberships and sales is not quite adequate to maintain our present level of operations. We can effect some short-term economies without noticeable damage, but about $1,000 per month over our usual income will be necessary to do a proper job.

If every one of the nearly 1000 L-5 Society members sent us a dollar, we would have another month to allow our income to catch up to expenditures through growth in Society size. You get what you pay for, *monumentum aere perennius* (translation sent to those who donate $1 or more during the next month).

WHAT’S AVAILABLE FROM THE L-5 SOCIETY?

- Xerographic reproductions of articles from other publications (please ask for list).
- *The Hunger of Eve: A Woman’s Odyssey Toward the Future,* Barbara Marx Hubbard, Stackpole Books, 1976. $8.00.
- *The High Frontier: Human Colonies in Space,* Gerard K. O’Neill, Wm. Morrow and Co., 1977. $8.00.
- *L-5* News, back issues $1 each (Volume included 16 issues).
- Bernal Sphere postcards (interior; exterior). 15¢ each; 50 of one kind, $3.
- Bernal Sphere 14” x 17” posters (interior, exterior). $3.50 for one, $3 each for two or more, $2.10 each for 10 or more, $1.75 each for 50 or more.

NOW AVAILABLE!

- *The Fourth Kingdom,* William J. Sauber, Aquari Corp., 1975, $6.00.

Note: Postage and handling per order, add $2.

IN THE L-5 OFFICE

Thanks to the staff and several volunteers (a tip of the hat to them), we succeeded in sending out a double mailing of the January issue and the Index, as well as sending out 500 answers in response to requests for information.

The posters (in full color) hopefully will be done and ready for shipment on the first of March.

* L-5: A POINT TO REMEMBER *

News from ERDA

ERDA SEEKS NOMINATIONS FOR NEW ENVIRONMENTAL ADVISORY COMMITTEE

The Energy Research And Development Administration (ERDA) has set up an Environmental Advisory Committee to increase public involvement in defining the goals and setting the policies of ERDA's environment, health and safety programs.

The Committee will advise the ERDA Administrator through the Assistant Administrator for Environment and Safety, Dr. James L. Liverman.

The new panel will provide advice on social, economic and institutional impacts of ERDA's energy programs; the preparation of environmental impact assessments and statements; biomedical and environmental research and planning; and occupational health and safety matters within ERDA facilities.

In addition, the Committee is expected to provide advice and counsel to ERDA's technical staff on natural and social science aspects of new and continuing programs.

"ERDA was established as the first agency with a clear mandate to give environmental concerns equal consideration in the development of energy technology," Dr. Liverman said.

"I believe the Environmental Advisory Committee will help us achieve a balanced approach to solving the problems which arise from the interactions of scientific, engineering, economic, social and institutional factors related to energy technology."

The Committee's 21 members, who will meet at least four times a year, will be drawn from the fields of science, medicine, engineering, industry, state and local government, and environmental protection, as well as from the general public.

Committee members will be selected by the ERDA Administrator from recommendations submitted by the Assistant Administrator for Environment and Safety.

Those wishing to submit names for consideration or desiring additional information should contact Dr. Joel B. Stronberg, Office of the Assistant Administrator for Environment and Safety, ERDA, Washington, D.C. 20545.

ERDA STUDIES UNCONVENTIONAL WIND ENERGY CONCEPTS IN 1977

Three advanced and innovative wind energy concepts are being explored in 1977 by the Energy Research and Development Administration.

Under research contracts issued late in 1976, the Grumman Aerospace Corporation of Bethpage, New York is studying and developing a vortex tower wind energy system; the University of Dayton Research Institute is analyzing a Madaras rotor power plant concept; and the South Dakota School of Mines and Technology, Rapid City, South Dakota is exploring the feasibility of extracting energy from humid air.

These projects are part of an overall ERDA program to develop wind energy, and they represent an examination of innovative concepts quite different from the conventional windmill. The ERDA-funded studies involve investigations of the feasibility of these concepts and examinations of their potential for significant improvement in energy cost over conventional windmills. The contracts resulted from the evaluation of over 50 unconventional ideas received in response to a request for proposals announced early in 1976.

Letters

I had a class in Community Services last semester [Fall 1976], and they became deeply involved in working on the alternative social structures for L-5. We were all very surprised at what appears to be a dearth of such planning in the materials we have received from NASA. The technology is carefully worked out, with tremendous amounts of research and reports. However, there is very little we are aware of that has been done in actually working out the possible social structures, and that is *as important* as the technological element. This is an unprecedented opportunity for planning, and there is enough research now that definite organizational systems can be created that will facilitate life in the space community! Not to do so would be such a vast mistake that one can hardly conceive of it. What this first colony does, the patterns it sets up, will have a major impact on the following communities-if and how they organize. Of course the research possibilities in such a closed environment are a sociologist's dream!

The students are going to continue working on the project, even though the semester and the class is over. Thus, they, and I, have an interest in all the materials we can find on the plans and development for the Space Colony. The whole area of space colonization was totally unknown to all of them, and I have been amazed at the interest they have shown, and the impact their work has had on themselves and their friends and families!

B. J. Bluth, Ph.D.
California State University
Northridge, California

L-5 SOCIETY MEMBERSHIP FORM (please type or print)
NL 702

L-5 SOCIETY
1620 N. PARK AVE.
TUCSON, AZ 85719

NAME: ____________________

ADDRESS: ____________________

CITY/STATE/ZIP: ____________________

AFFILIATION/TITLE OR POSITION: ____________________
(OPTIONAL)

I am am not interested in being active locally. Phone (optional) ______ ____________

__ Please enroll me as a member of L-5 Society ($20 per year regular, $10 per year for students). A check or money order is enclosed. (Membership includes L-5 News, $3 to members; the balance -- $17 or $7 -- is a tax-deductible donation.)

__ Please enter the above as a nonmember L-5 News subscriber ($20 per year). A check or purchase order is enclosed.

__ Enclosed find a donation of $__________. (Donations to L-5 Society are tax-deductible.)

I opened up the paper this evening *[Kansas City Star)* and looked through the editorial page as I usually do when I stumbled across the following statement: ". . . President Carter's budget experts are looking at the proposed fiscal 1978 budget for the National Aeronautics and Space Administration as a likely place where cuts can be made and the money diverted to social programs."

ARGH!! I don't know if we can mount a letter-writing campaign in time to stop this madness, but I think we'd better try. We're not going to get space colonies or anything else up there unless we can demonstrate that the people of this country (or at least a sizeable fraction thereof) are in favor of the space program, and the bigger the better! The Space Shuttle is absolutely vital to everything we believe in.

I don't know how you (the L-5 Society) feel about this, but if it were up to me I'd give it top priority and tell as many of the members as possible to write directly to the President, 1600 Pennsylvania Ave., Washington, D.C., and let him know how we feel about this matter.

Is it possible to send a letter or postcard to all the members of the L-5 Society and inform them of the fact that the NASA budget might get cut? You don't have to tell them to write and protest this abominable idea, but you might suggest that Mr. Carter might react positively to a couple of hundred letters on the subject. We might also want to get in touch with the Star Trek people and anyone else who shares our views about the importance of space to our future, and get a massive letter-writing campaign started.

Robert G. Lovell
Shawnee, Kansas

[The Society can't get involved in lobbying, but we will print letters from members on relevant subjects.]

If the Viking results indicate that Phobos and Deimos are really carbonaceous chondrite material, then we have a deep space source of volatiles such as carbon, nitrogen, and hydrogen, without having to drag it up from Earth or snag a passing comet. I'd like to see a study of the transport of such materials from Mars orbit to L-5, or even better, the emplacement of Deimos or a large hunk thereof at L-4.

Mining the asteroids sounds neat, and raiding Saturn for volatiles also is exciting, but the delta-V requirements alone become prohibitive, not to mention the trip times. Of course, who says we have to build the colonies near Earth anyhow, except perhaps because we may hug close to the Sun to draw its power. Out past Mars we may set up new manufacturing sites but might need alternate sources of energy.

The Earth-crossing Apollo asteroids are more bits and pieces of available resources, but since their periods are very close to that of the Earth, the resulting synodic period may be measured in decades. While the theoretical delta-V to get to 1976-AA and back is the lowest for any other object in the Solar System, the launch window does not recur until the early 1990s.

Recall that we once thought Phobos might have been a spacecraft but everybody said that ten-mile-wide space vehicles were a thousand years beyond human technology. Now, of course, we will build satellites of that size in a few decades. We will build Phobos-sized artificial worlds a thousand years sooner than experts had estimated twenty years ago. Of course, we have an advantage over the Martians: we will do it with natural lunar materials, which more than makes up for the Martian advantage of lower primary gravity. Well, forget the fantasy; Phobos is a natural object. If we ever expect to find ten-mile-wide spacecraft in the Solar System, we will have to build them ourselves.

James E. Oberg
Dickinson, Texas'

I would like to thank Mr. Aldo Pontecorvo for his letter in the November issue, in which he points out something of which I was unaware. This is that it is food technologists, and not chemists, who would have the responsibility for development of food products from sources such as soybeans, TVP (textured vegetable protein). Mr. Pontecorvo may rest assured that now that I am aware of this, I would certainly advocate that people from this discipline, food technology, should consider the contributions they might make to a colonization program, in which no doubt they would be entirely welcome.

As for the *L-5 News* in general, as one who has received every issue since the first, I too am impressed by the recent improvements in its quality. To me, what is most noteworthy is your use of major articles in such areas as NASA's space-station program, von Puttkamer's advanced planning activities, and Criswell's analysis of space-resource economics. These articles have been entirely on a par with articles appearing in such journals as *Aviation Week* and *Astronautics and Aeronautics.* Insofar as such topics have not yet been treated in these journals, however, it is evident that *L-5 News* is becoming a valuable resource for the aerospace professional and a useful reference for work in management or advanced planning.

Many have speculated as to the future of *L-5 News.* May I offer a modest suggestion? Late in 1945, Eugene Rabinowitz and his colleagues, at the University of Chicago, founded the *Bulletin of the Atomic Scientists.* At first it was just a mimeographed newsletter, but it soon grew to become a leading journal of viewpoint and opinion, and of interest to many people outside the nuclear community. May I predict a similar future for *L-5 News?*

T. A. Heppenheimer
Max-Planck-Institut fur
Kernphysik
Heidelberg, Germany

IN THIS ISSUE:

Opportunities for Students 1
Space Research and the Military 3
The Consequences of Extraterrestrial Colonization 5
The L-5 Society Slide Show 7
Flash! O'Neill Leaves for Saudi Arabia 17
Inside the L-5 Society 18
News from ERDA 19
Letters 19

LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

L5 NEWS

VOLUME 2, NUMBER 4

APRIL, 1977

NEW MOONS: Mining the Asteroids

All but the newest readers of the L-5 News are familiar with the "orthodox" aporoach to space habitation/industrialization. In this approach, the lunar surface is used to supply new materials, though mention is given to the later use of asteroids as richer sources of materials. The "heretical" approach skips the lunar surface and goes directly to the asteroids. Even more outrageous things will be reported in coming months-laser launched rockets ($2O/kg to geosynch) and high performance solar sails, etc. But for now ....

Towing Asteroids into Earth Orbits for Exploration and Exploitation

Special Session of the Eighth Lunar Science Conference, March 16, 1977 organized by Dr. David Criswell

Two recent developments encourage immediate consideration of the possibility of bringing asteroids into orbits about the Earth for exploration

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and exploitation:

(1) The distribution of crater sizes on the Moon, Mars, Mercury, and the Earth, and recent astronomical surveys indicate the possible existence of many thousands of asteroids larger than 100 meters in diameter in orbits approximately 1 AU (astronomical unit) from the Sun and with velocity differences with respect to Earth of approximately 3 km/second, or less. Retrieval of such asteroids requires 10 to 100 times less energy than for similar main belt asteroids located between Mars and Jupiter.

(2) The mass-driver, first proposed for ejecting soil pellets from the Moon, can be used in space as an electric rocket engine. A mass-driver coupled to a 100 megawatt power plant (possibly a solar array) could be assembled in low Earth orbit. Reaction mass necessary to propel the mass driver tug for the 3 to 9 month cruise to rendezvous with an asteroid could be obtained by pelletizing the oxygen/hydrogen tanks from the 30-50 shuttle flights necessary to lift the tug assemblies into low Earth orbit. After rendezvous, the tug would cruise back to Earth in 3 to 5 years using approximately 80 percent of the asteroid as reaction mass. Conceivably, the initial venture could return 10,000,000 metric tons of material to Earth orbit for less than 20 cents per kilogram (versus $1000/kg for shuttle and tug launch to geosynchronous orbit) by the mid-1980s at a cost of one to two billion dollars.

Scientific results of immense importance should result from studies of virtually unlimited quantities of the materials returned. Asteroids should provide considerably less altered samples of early solar condensates than obtained from the Moon or certainly from Mars. At long last cosmochemists can do "whole" rock analyses. Of far wider interest is the possible economic potential.

Speculative Scenario:

Between mid-1977 and 1979 intense ground-based and space (possibly using surveillance satellites) searches discover several Earth-crossing asteroids larger than 100 meters diameter, with small velocity differences with respect to Earth. A nuclear or solar powered tug is deployed by 1981 in the first major shuttle program, and asteroid rendezvous and docking occur in mid-1982. Automatic analysis of asteroid material supplied to the mass driver allows between 1982 and 1985 for design, fabrication and deployment of chemical processing equipment and manufacturing machinery. People, machines, and the asteroid rendezvous in high Earth orbit in 1985. Now hollowed-out, the asteroid provides raw materials for construction of space solar power stations of three trillion watts output and simultaneously a shelter against radiation for workers. (Presently, the U.S. consumes 500 billion watts per year and needs 60 billion watts per year of new electrical generating capacity.) The first remotely located ground/sea stations are designed to receive very high microwave beam densities from the space platforms in order to speed construction, lower costs and allow industrially significant production of synthetic fuels for immediate input to the U.S. tanker and pipeline networks starting in 1987. They will meet all demands for new energy supplies for the U.S. by 1990.

L-5 in Congress

Testimony of Dr. T. Stephen Cheston, Associate Dean, Graduate School, Georgetown University, Before the Science and Space Subcommittee, Committee on Commerce, Science and Transportation, United States Senate, March 17, 1977

Senator Stevenson and Members of the Committee:

I appreciate very much your invitation to share with the Committee observations on developments related to the proposed NASA budget.

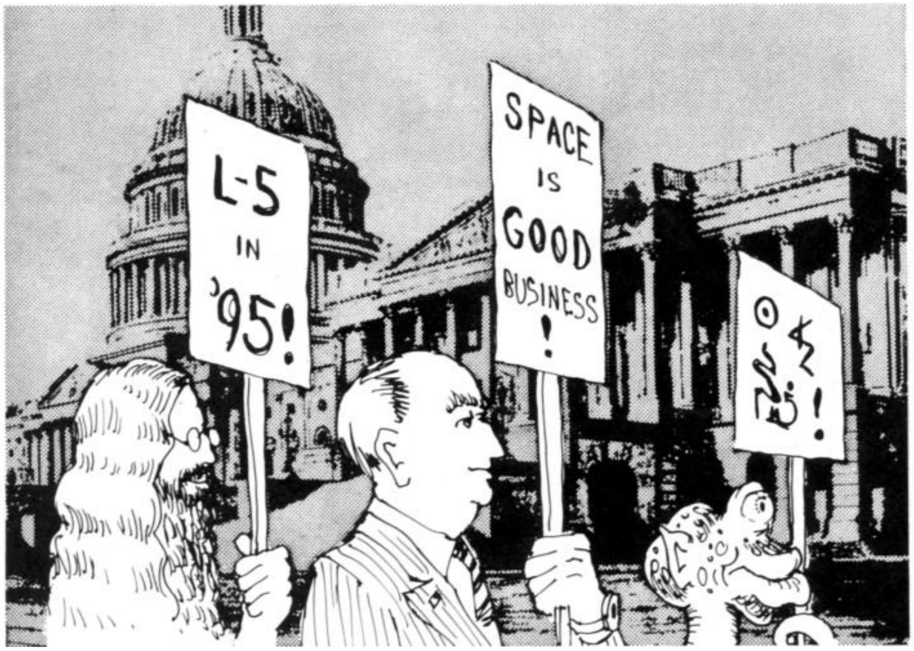
My principal intention is to invite the Committee's attention to two new groupings that are emerging in regard to space development. One is oriented towards educating public opinion, while the other is primarily academic and university-based.

I would like to begin by outlining very briefly the background of support for space endeavors, albeit in a very simplistic fashion. Surveys have concluded that popular support for space during the 1950s and 1960s arose from the public's desire to have the United States preeminent in its competition with the Soviet Union. Space was a symbol of national prestige and U.S. progress in this area polished the American image around the world. This support provided the backdrop for the development of the well-sized space enterprise that begat substantial labor and industry involvement. These interests, in turn, became advocates of space for the obvious reasons that it provided jobs and company earnings. With the winning of the race to the Moon, the force of public support for space dissipated to a large degree and left advocacy for space development primarily in the hands of labor, industry and professional groups who were its immediate beneficiaries. These latter groups were not sufficiently strong to protect NASA in the early 1970s from fairly substantial budget reductions and a major debate over the efficacy of the Space Shuttle.

In the mid-1970s, however, a subtle but significant change began to take place. New concepts emerged focusing on the utilization of space that triggered interest and support for space development from groups and individuals who had not been previously involved in it. I wouldcount myself among them. In this regard, I think we should take a special note of the work of Gerard O'Neill, Professor of Physics at Princeton University, on space manufacturing/colonization, Peter Glaser of Arthur D. Little, on the satellite solar power stations, and Krafft Ehricke of Rockwell International, on space industrialization. Their work gained prominence for the first time, or renewed prominence in the case of Peter Glaser, in the wake of the environmental and "limits to growth" concern about the outcome of the exponential growth of our current industrial patterns. Unhappy conclusions were being drawn about the future of our society and creative thinking was necessary to come to grips with these critical issues in a substantive way. Creative thinking came from O'Neill, Glaser, and Ehricke, who posed ways to partially solve the problems of pollution and resource depletion by moving at least some of our industrial capacity into space. I won't go into any specifics about their concepts on the assumption the Committee will receive this information from other sources. I will just say that these concepts have caused space to be looked at in an entirely different light than before, and it is viewed this way by groupings in our society that are only now beginning to manifest their interest.

The first of these new groupings is fairly well-articulated and identifiable. It is the various coalitions of individual citizens that have united their resources and energies to educate the public on the potential of space. They are kind of "Common Cause" organizations for space development and reflect deep grass-roots interest. Some of these coalitions are propelled in part by youthful energy that is somewhat reminiscent of the anti-war movement of the late 1960s and at times are strange combinations of disparate sectors of our society. They combine under single organizational roofs elements that remind one of counter-culture/radical activism, with senior officials of industry, whose hallmarks are restraint, caution and conservatism. They combine utopian visionaries with pragmatic bureaucrats whose primary concern is next year's budget.

A group of this sort that I have concrete knowledge about is the L-5 Society, based in Tucson, Arizona. It came into being in July, 1975, with the professed goal of educating the public about space industrialization, satellite


L-5 IN '95!
SPACE IS GOOD BUSINESS!

solar power and space habitats. It has over one thousand members and is growing rapidly.

Some youthful members in these public education organizations have difficulty in understanding why the United States does not immediately devote vast resources toward these goals. . . . For the most part, however, the membership of organizations such as L-5 are very realistic, seeking common-sense solutions to resource and environmental problems through the utilization of space. They are a healthy force on our body politic.

The important element here is that these citizen groups did not exist until very recently and they are growing. It is not unreasonable to expect that they will develop some political force, but the level to which it will develop is a matter of debate and conjecture at this time. However, it should be recognized that this force is now in its embryonic state.

As mentioned before, the focus of these citizen groups is on the industrial utilization of space and this activity is reflected in various areas of the NASA budget. First among these, of course, is the Space Shuttle. It is the key to access to orbit at commercially tolerable costs. No doubt the Committee has heard about the value of the Shuttle as an economically acceptable space transportation system from other sources and in detail. I won't belabor the point, but only add that many in the citizen groups I have noted look upon the Shuttle as one of the wisest investments in the nation's history.

At this time, NASA does not have a separate and so-named organizational entity to coordinate space industrialization efforts. The Office of Space Flight Operations has assumed this responsibility and is approaching its tasks in this area with a great deal of dynamism. However, I believe that it might be advisable to develop formats for tighter coordination of programs related to space industrialization which may entail establishing a new, high-level office within NASA that would enjoy wide ranging authority. This might be an item worthy of the Committee's attention during the upcoming year. In the meantime, the following sectors of the proposed NASA budget cover activities that are directly relevant to the progress of space industrialization:

I. Space Flight
    Space Flight Operations
        Advanced Programs
        Planning and Program Interaction
II. Space Sciences
    Life Sciences
III. Space Applications
    Materials Processing in Space
    Space Communications
IV. Aeronautical and Space Technology
    Space Research and Technology
        Research and Technology Base
        Systems Studies
        Systems Technology Programs
        Experimental Programs
        Low-Cost System Programs
V. Energy Technology Applications

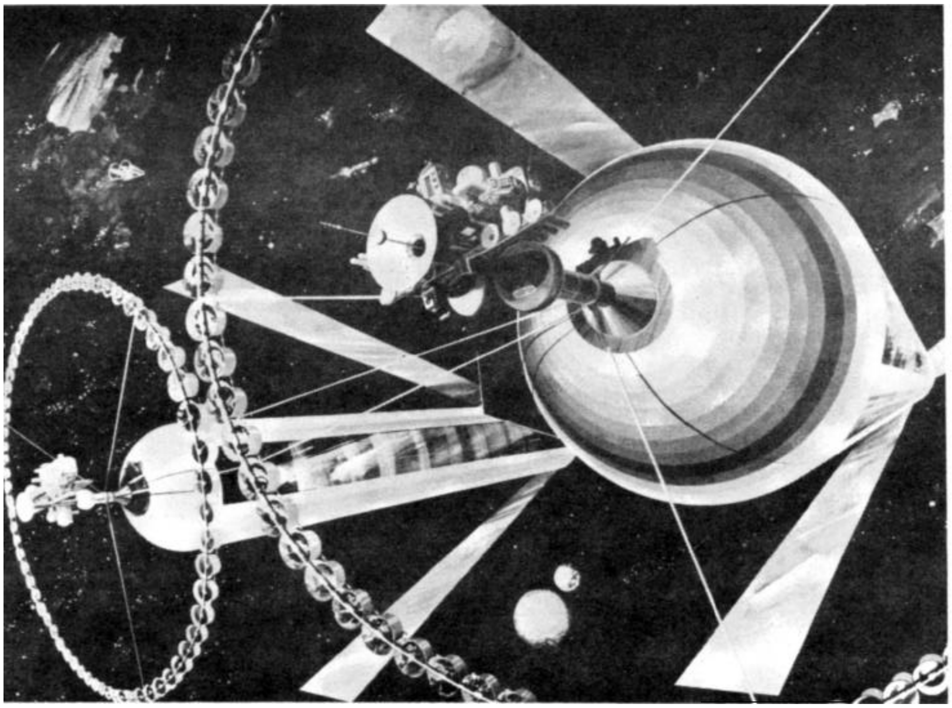
There is an additional item in the budget related to the industrial utilization of space that deserves the Committee's attention. In the FY '78 budget, there is $1 million for Satellite Solar Power Systems under Energy Technology Applications. Presumably ERDA was to take up fiscal responsibility for these activities in accord with the recommendation of the ERDA Task Group on Satellite Power Stations, which called for funding SSPS at either $3.25 million or $5 million per year for the next four years. The work in this area would be undertaken through the joint ERDA/NASA Coordinating Committee. However, in ERDA's FY '78 budget there is only $200,000 for SSPS.

Consonant with the basic thrust of the recommendations of the ERDA Task Group, the House Subcommittee on Space Science and Applications increased the FY '78 authorization for Energy Systems/Satellite Solar Power Systems by $5 million to support much needed further study on system definition and to initiate a comprehensive environmental impact and benefit analysis of SSPS. I believe the House action is a valuable contribution to advancing research on this promising area of future energy production and deserves serious consideration.

The second new grouping that I would like to bring to the Committee's attention has no specific shape and at the moment is of ill-defined size, but draws its members from the academic and intellectual community related to the social sciences and the humanities. These individuals, for the most part, have not been previously involved or even interested in space development. They passed through the Apollo era as passive observers and took no specific initiative to participate in it. They did not at that time exhibit the spontaneous, genuine interest that is the well-spring for new activities. This, however, is now changing, albeit still on a very modest scale. The Glaser, Ehricke, and most especially the O'Neill concepts have caused these academics to begin looking at the potentials of space from the perspective of a variety of disciplines. Anthropology, sociology, history, psychology, architecture, political science, law, economics, geography, ecology and international relations are being brought to bear on these concepts by spontaneous individual action rather than program initiative from NASA. Dr. O'Neill's correspondence now runs well into the thousands, with many of the letters coming from social scientists and humanities scholars. Concrete manifestations of this interest have taken such form as a course in space colonies now offered at the University of North Florida and a faculty working group at Georgetown University to look at the possibilities of developing faculty seminars, graduate and undergraduate courses and a scholarly journal on space industrialization and its impact on society.

In looking at the dialogue that is emerging on space development, one gets a sense that the academics feel that something is up and that it is important -- important enough for at least some of them to begin to examine the new directions of this industrial development which they perceive as beginning to take form in the 1989s and 1990s. They recognize that the "Copernican Factor," as I call it, is beginning to seep into our industrial thinking and that it is only a matter of time before it becomes a

(Continued on Page 12)



(1) Exterior of a possible "Island Three" space community. Living areas, agriculture, and industry, though located within a few miles of each other, have separately chosen temperature, climate, day-length, and gravity. (R. Guidice, NASA)

islands in space

Excerpt from The High Frontier, *Gerard K. O'Neill, William Morrow and Co., Inc., 1977. By permission.*

Over half of the people in the Society haven't yet ordered O'Neill's The High Frontier *from us! We hope it's because you have convinced your local bookstores to carry this incomparable treatise on the human future in their front window by descending upon them in a book-buying frenzy. Those few of you who haven't obtained the book by one method or another are missing something! Following is a choice excerpt- for the rest of the picture, dash down to your nearest bookstore or dump an order in the mail to the L-5 Society.* - C H

I have argued that there is only one way in which we can develop truly high-growth-rate industry, able to continue the course of its development for a very long time without environmental damage: to combine unlimited solar power, the virtually unlimited resources of the Moon and the asteroid belt, and locations near Earth but not on a planetary surface.

I will describe first a community of what I like to call "moderate" size; it is larger than the first model habitat, but far below the dimensions of the largest that might be built. "Island Three" is efficient enough in the use of materials that it could be built in the early years of the next century. The numbers will seem staggering, but they are backed by calculation: within the limits of present technology "Island Three" could have a diameter of four miles, a length of twenty miles, and a total land area of five hundred square miles, supporting a population of several million people. The largest communities that could be built, within the limits of ordinary, present-day structural materials like iron and aluminum, and with oxygen pressures equal to 5,000 feet above sea level on Earth, could be about fifteen miles in diameter, seventy-five miles long, and could have a total land area of as much as seven thousand square miles; about half that of Switzerland. It would be uneconomic at first to build habitats that large; they would be wasteful of materials. In the long run, though, the human race may build habitats of that size, or, with more advanced technologies, even larger.

We need to provide gravity, water, land, air, and natural sunshine in an Earthlike environment. Rotation can simulate gravity, and fortunately there are at least two geometries that allow rotation while giving us the real Sun stationary in the sky. One is a coupled pair of cylinders, whose long axes are parallel to each other (Figure 1). The cylinders are closed by hemispherical endcaps, and contain oxygen. Each cylinder rotates about its long axis, so that people living on its inner surface feel an Earth-normal-gravity.

The cylinder circumference is divided into six regions, three "valleys" alternating with three arrays of windows. By locating three large, light planar mirrors above the windows, and pointing the cylinder axes always toward the Sun, we can arrange that the valleys will receive natural sunshine, and that the Sun will appear motionless in the sky even though the cylinder is rotating. Varying the mirror angle will give dawn, the slow passage of the Sun across the sky during the day, and sunset. The day-length, weather, seasonal cycle and heat balance of the colony can be regulated by the same schedule of mirror-angle variation. A large paraboloidal mirror at the end of each cylinder can be collecting solar energy twenty-four hours per day, to run the community's power plant.

If we then set up many smaller cylinders near the big ones, and use the small ones for the growing of crops, we will achieve what has never been possible on Earth: independent control of the best climates for living, for agriculture and for industry all within a few miles of each other.

The "valley" areas, in Island Three, would each be two miles wide and twenty miles long, rising beyond that to mountains. These mountains, formed on the inner surfaces of the cylinder endcaps, could have a height of up to 10,000 feet (Figure 2).

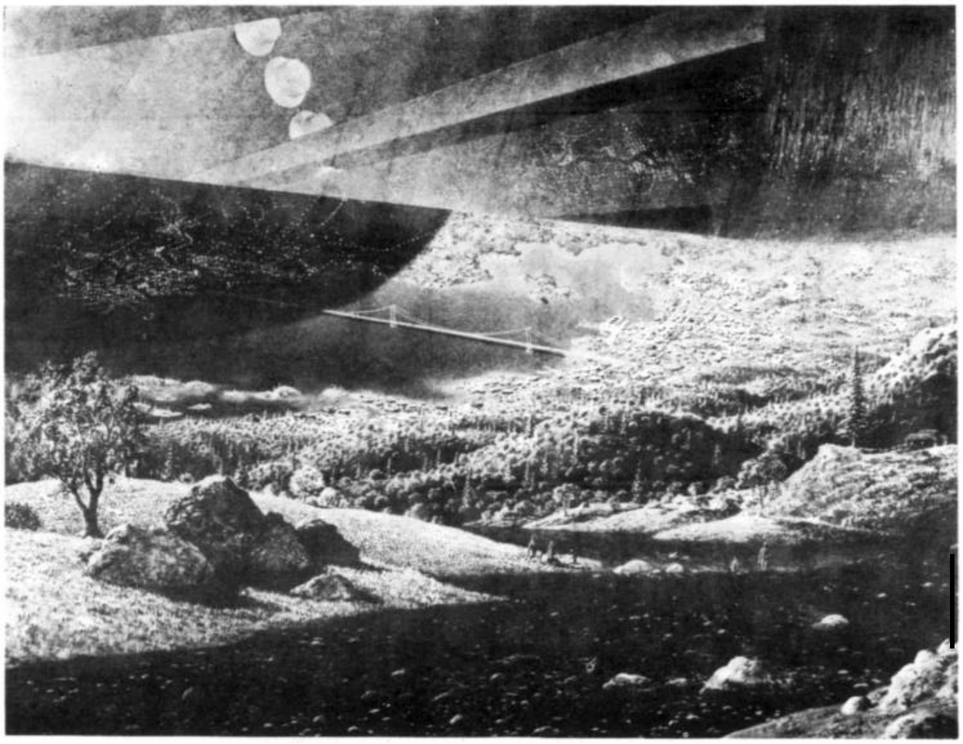
In the simplest version of a space-community design, sunlight will be reflected into the habitat by large plane-surface mirrors, attached by many cables to each rotating cylinder and rotating with it. A dweller in one of the valley areas will look up and see a blue sky, obtained probably by art rather than by nature. It will be rather easy to control the reflectance of the mirrors and the tinting of the windows ("solars") to produce the most pleasing combination of warmth and brightness for the sunshine falling on the valleys, and to give a blue tint to the solars. There will be no sensation of rotation, though the cylinder will be turning once every two minutes; gravity in the valley areas will be Earth-normal. No one in the space habitat will be in any doubt as to where he is, though: high above him, far above the clouds at a height of 20,000 feet, he will see, dimmed by distance, the other two valleys of his home. From that far away they will be as indistinct in detail as the Earth's surface is from an aircraft four miles high, but the inhabitants will be able to see them.

The angle of the sunlight entering the habitat will be controllable, and will depend only on the lengths of the cables which hold the mirrors. As the mirrors slowly open in the morning, the Sun will rise, but will move in the sky only as fast as it does on Earth; there will be no suggestion from its appearance that the cylinder is actually rotating. Only with very delicate instruments could one find that the image of the Sun's disc is rotating around its center.

With control over the angle of the Sun in the sky, the residents of space will also have control over the lengths of their days, the variation of the day-length, and so the average climate and the seasons. They are unlikely to indulge in any sudden or capricious changes in those variables. Humans can adjust quickly, as the jet age has shown us, to changes in the day/night cycle and the climate; plants and trees, though, are not so adaptable, and once a cycle has been established there will be good reason to make changes in it only very slowly.

By the time a community as large as Island Three is built, space habitats may not be occupied at the ecological limit: the highest population density that the land can support. In the early years of the next century Earth will be from two to three times as crowded as it is now, and the population density in space habitats may be falling toward the same value as that of Earth, ultimately to cross it and fall still lower. Island Three, however, could support quite easily a population of ten million people, growing its food in agricultural cylinders near but outside the main habitat. In the figure of habitat cost per person, I will assume that higher density. We are used to the perpetual conflict, here on Earth, between industry, agriculture, and living space, but we must realize that in a space habitat economics will dictate escaping that conflict by locating agriculture a few miles away from the living areas. It is relatively expensive in materials to build large cylinders, with diameters of several miles, and relatively expensive to provide sunlight of normal appearance. Plants do not need such luxuries, and can be grown very efficiently in places where the solar intensity is high, but where there are no visual amenities.

With industry and agriculture located outside, the dwellers in Island Three can use their two hundred and fifty square miles of land area for living space and recreation. I suspect that as colonists from various countries of Earth arrive to settle the many communities in space, there will be a great variety in the ways in which land area will be used. Some immigrants may choose to arrange their land area in small villages, with single-family homes, the villages being separated by forests. Others may prefer to build small, intimate towns of high population density, to enjoy for example the color and excitement and human interaction that is so much a feature of small villages in Italy. With many new communities to choose from, the emigrants from Earth will settle in those they like best. I would have a preference, I think, for one rather appealing arrangement: to leave the valleys free for small villages, forests, and parks, to have lakes in the valley ends, at the foot of the mountains, and to have small cities rising into the foothills from the lakeshores. Even at the high-population density that might characterize an early habitat, that arrangement would seem rather pleasant: a house in a small village where life could be relaxed and children could be raised with room to play; and just five or ten miles away, a small city, with a population somewhat smaller than San Francisco's, to which one could go for theaters, museums, and concerts.



(2) A possible interior landscape for an "Island Three" community. Artist's view is from a hillside high on an endcap, looking over one of the valleys. (D. Davis, NASA)

HOW FARE WOMEN SCIENTISTS?

The number of women employed full time as scientists and engineers by universities and colleges reached 35,900 in January, 1976. This was the second consecutive year that their numbers have increased by five percent. Men, still far outnumbering women, totaled 194,000 in 1976, but their rate of increase was only two percent in each of the last two years, according to findings reported in the National Science Foundation's *(NSF) Science Resources Studies Highlights.* Also, despite the higher growth rate for women, there has been little change in their share of the full-time scientists and engineering total-up from 15 percent to 16 percent between 1974 and 1976.

The Commission on Human Resources of the National Research Council also reports that women PhD.s in science and engineering continue to make less money and find themselves out of work more often than their male counterparts.

According to the 1975 profile, the median annual salary for all men and women doctoral scientists and engineers was $23,000, with engineers earning the highest median salary -- $25,000. The median salary for men was $23,000, while the median for women was only $19,000. Female doctoral engineers fared slightly better: their median salary was about $21,000, compared to over $25,000 for male engineers.

The 1975 report also shows a 3.0 percent rate of unemployment among female science and engineering PhD.s, compared to 0.8 percent for men. However, there is a slight improvement over 1973 figures when this job market showed 3.9 percent unemployment for women and 0.9 percent for men.

ON THE O'NEILL SPACE COLONIES

Ju!iann M. Forman

A glowing ring of fire
thrown wide and free
cradled in black
it calls to thee.

Come work and live
come breathe and run
rotating
revolving
held by thread of gossamer
tied to Earth and Sun.

Quiescent, the silver ring waits
animation. Questing, the ship
probes slowly within.
The ring fills with life.

"'Home," comes the whisper.
Home, and thereby
hope springs eternal
that man not die.

Waste Heat Rejection Methods for Space Habitats

Given we have large scale space communities, how do we keep them cool? Air conditioning technology applied on a macro-level provides two possible answers.

H. K. Henson

[Author's note: The following article is by no means the last word on this subject. It was written for a class on space agriculture mostly to illustrate the use of physical and economic models Cost figures are arbitrary.]

In a space farm, virtually all of the incoming energy, in the form of sunlight or electricity, will wind up heating the air. The Stanford torus, for example, has about 80 square meters per person of living space, illuminated to an average level of 500 watts per square meter, or about 40kw. per person.' Most of the heat load, 90 percent or more, is from crop illumination. The alternative to growing food is importing food, scrubbing the carbon dioxide from the air and adding oxygen from the industrial plant. One or two percent of the energy falling on crops is converted into stored chemical energy. However, this is balanced by an equal amount of heat being returned to the system through the metabolism of food and waste being burned for carbon recovery.

Consider then the problem of disposing of this 40kw. per person, or 400,000kw. for a colony of 10,000 people. Forty kw. is the equivalent to melting eleven tons of ice per day. This "ton," 12,000 btu per hour in the English system, is a commonly used measure in air conditioning. To get a feel for the size of the problem, the University of Arizona with 35,000 students has about 7,000 tons of air conditioning capacity. The space farm with only 10,000 people will require 110,000 tons!

The only way to dispose of large amounts of heat in space is by radiation. The radiation rate is given by:

$$R = erT^4$$

Where: R is the radiated energy in watts per square meter, e is the emissivity of the surface, r is the Stefan-Boltzman constant, (approximately 5.67 x 10^{-8} watts per square meter-degree K^{-4}).

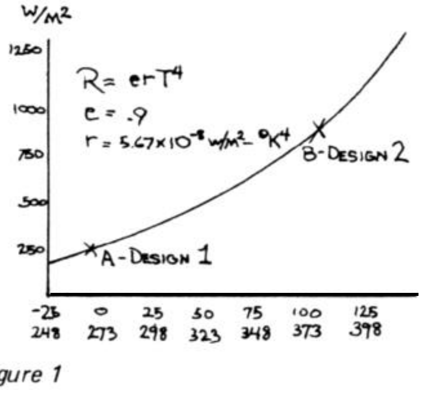


Figure 1

Surfaces with emissivity of 0.9 are not hard to produce. (The graph Figure 1 is radiated heat vs. T, for e = 0.9.)

It becomes apparent that, even though the emitted energy is a function of T^4, the range over which we are interested is so small that the effect is almost linear. There is little reason for air conditioning temperatures to go much below freezing (O°C) and the upper temperature (125°C) is determined by the energy considerations and available air conditioning technology.

Two radiator systems will be designed and compared: a low temperature or "passive" system which operates at point "A" on the graph, and a high temperature or "active" system operating at point "B." Costs are determined from Table 1.

Table 1 – Cost Standards

Lunar Oxygen	$ 5/kg
Lunar Aluminum (simple shapes only)	20/kg
Earth-L-5 Transportation	200/kg
Electric Power	2000/kw

First, let's consider a design for an inside portion of the system which could be connected to either radiator system. A chilled water air conditioning system has advantages in that the heat exchange medium is non-toxic, non-combustible, and has high conductivity and specific heat, the technology involved is well developed, and with rotating joints it would be easy to separate the rotating section of the space farm from the non-rotating radiator.

Some of the disadvantages of this system are that large amounts of expensive water are required and that the lowest temperature is not very low. This makes large and thereby costly heat exchangers necessary. The standards[2] used in the design of the heat exchangers within the farm are: 8 feet per second velocity water flow; 2 gallons per minute per ton of capacity flow rate; 150 kg of heat exchanger per person; 1 kw. blower power per person.

With these numbers, and the dimensions of the Stanford torus, we can compute the materials needed and the cost per person.

1000 kg of water @ $25/kg	$25,000
150 kg of heat exchanger @ $200/kg	30,000
1 kw. of blower energy @ $2000/kw.	2,000
Total per person	$ 57,000

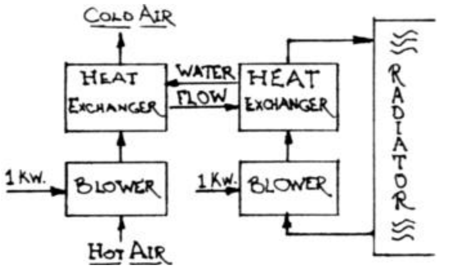


Figure 2A

Now let us consider two methods of disposing the heat which our conditioner accumulates, a passive system (2A) and an active system (2B).

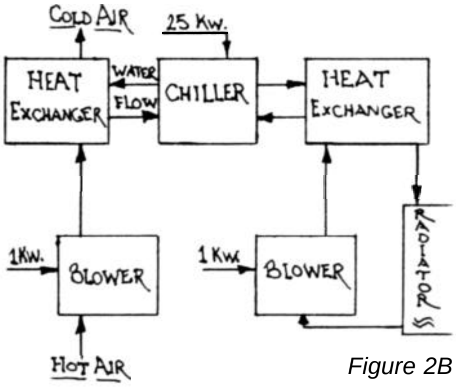


Figure 2B

Design one, the low temperature system, operates at -8°C average temperature and radiates 250 watts per square meter. The area required per person then is 80 square meters (both sides are used) or 800,000 square meters for our population of 10,000. This is equivalent to a square almost 900 meters on a side! A reasonable minimum thickness would be approximately one percent of the linear dimensions, or 10 meters. The radiator must be filled with something to transfer the heat, and since oxygen is inexpensive, let's fill it with oxygen at 5 psi. This way we can work within it when repairs are required due to meteor holes. In section it might look like Figure 3.

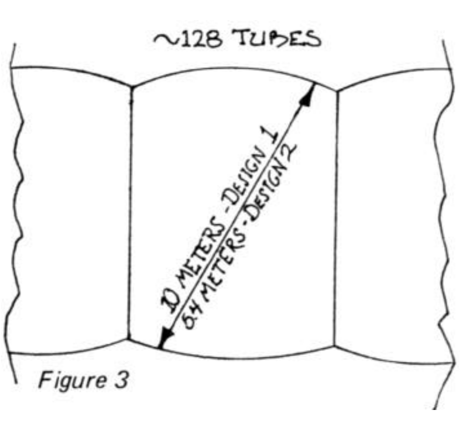


Figure 3

The aluminum required to hold 5 psi in this configuration would have an equivalent thickness of .9 cm or .35 inch. More calculations yield:

1940 kg of Al @ $20/kg	$ 38,800
312 kg of oxygen @ $5/kg	1,560
subtotal	40,360
150 kg of heat exchanger @ $200/kg	30,000
1 kw. of blower power @ $2,000/kw.	2,000
subtotal	32,000
total	$ 72,360

The high temperature design radiates four times as much heat, 1 kw. per square meter at an average temperature of 373°K (100°C). Due to the energy added by the chiller (25kw. per person), the total heat radiated per person is 65kw., which implies an area (two sided) of 37 square meters. This is 46 percent of the area of the low temperature design and only about 30 percent of the mass. (Corresponding to a square 610 meters on a side). Using a thickness of 5.4 meters and scaling from the low temperature design we get:

540 kg of Al @ $20/kg	$ 10,800
86 kg of oxygen @$5/kg	430
subtotal	11,230
150 kg of heat exchanger @ $200/kg	30,000
250 kg[3] of chiller @ $200/kg	50,000
26 kw. of power @$2,000/kw.	52,000
subtotal	132,000
total	143,230

or about twice as expensive per person.

So, for this example, with the choice of cost factors we made, the cost indicates that the low temperature heat radiator system is superior. Building the chiller out of lunar materials and lower cost power would, however, change the picture.

References:
1. NASA SP-431, p. 85,98.
   Note: Page 85 gives 1000 w/m^2 for agricultural areas approximately one-half of the total, 200 w/m^2 for residential and 50 Mw. for electricity -- approximately 37 kw. per person. Page 98 gives 131 Mw. total or 13.1 kw. per person.
2. Personal communication with T.F. Walker.
3. Mechanical Estimator Handbook, 1976.

BIBLIOGRAPHY UPDATE

Economical Orbit: SSoar--A Freighter to Space. Earth/Space Press, 1976.

Carolyn Henson

Interested in the potentials for free enterprise activities in space? This document contains much of value to the hopeful space entrepreneur. To quote Paul Siegler, President of Earth/Space:

> Earth/Space has assembled this document in the hope that it will demonstrate the promise of space to you as a consumer, businessman, or interested individual. When people describe the potential of space only in terms of the scientific advantages to be gained, or as an arena in which strategic control can be assumed, we believe they are mistaken. Our philosophy is that space can be-and will be-used to bring material benefits as well as a sense of adventure to those who live on Earth. Opening up space to peaceful uses by individuals, groups, and nations will enrich our lives in many undreamt ways. Some of the benefits-such as excursions into orbit by small, inexpensive launch vehicles-will soon be visible, promising to put spaceflight within the grasp of thousands. This report will explore the benefits of space and a means of gathering them.

The primary purpose of the document is to describe SSoar (Single Stage to orbit and return), a space vehicle first conceived by Phil Bono, a leading Douglas engineer, in the early 1960s. However, even those who are not transportation buffs will find the sections on subjects such as "Survey of Major Corporations on Space Industrialization," "The Market Potential for Space," "Space Applications for Profit Near Term," "International Law and the Private Launch Corporation," "Space Treaties," etc., to be a valuable compendium of space-oriented information. Hard-bound copies are for sale for $25 each from Earth/Space Press, 4151 Middlefield, Palo Alto, California 94303.

"O'Neill's Space Colonies: An Ecological Solution That's Out of This World," Conway Marsh, *Cosmic Frontiers,* Vol. 2, Issue 1, pp. 54-59.

"Ecological Considerations for Space Colonies," *CoEvolution Quarterly,* Winter, 1976/77, pp. 96-97.

"Salyut-4: The Space Race of Lazarev and Klimuk," James E. Oberg, *Spaceworld, Nov.* 1976, Vol. M-11-155, pp. 4-29.

"A Programme for Interstellar Exploration," Robert L. Forward, *The Journal of the British Interplanetary Society,* Vol. 22, No. 10, Oct. 1976, pp. 611-632.

NEW PUBLICATION ABOUT THE MOON

A new publication entitled *What's New on the Moon?* has been produced at NASA Headquarters. The author is Dr. Bevan M. French, Program Chief, NASA Extraterrestrial Materials Research Program. A geologist, French has studied lunar samples and terrestrial meteorite craters for more than ten years. The booklet, replete with dramatic photographs and diagrams, reviews the events that led to Moon landings and delineates many of the findings that resulted from Apollo missions to the Moon. The booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 as Stock No. 033-000-00653-5. A single copy is $1.00; multiple copies are S.70 each. The text with colored pictures is to be published in the March and April issues of *Sky and Telescope.*

BORROW A PIECE OF THE MOON

NASA has prepared a sample package containing thin sections of lunar material for student and faculty use. The purpose of this program is to broaden the use of the lunar sample collection for scientific and educational purposes. On a first-come, first-served basis, the Thin Section Educational Package is now available to any academic institution offering undergraduate or graduate courses in the geosciences. NASA is also working on a distribution plan for both junior and senior high school levels. For additional information contact: Dr. Michael Duke, Lunar Sample Curator, Code: SN2, Lyndon Johnson Space Center, Houston TX 77058. Telephone (713) 483-4464.

INTERNATIONAL VIEW

EQUATORIAL NATIONS CLAIM GEOSYNCHRONOUS ORBIT PORTIONS

Representatives of Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda, and Zaire met in Bogota, Colombia from November 29 through December 4, 1976, for the purpose of studying "the geostationary orbit that corresponds to their national terrestrial, sea and insular territory and [is] considered as a natural resource."

They concluded that "the segments of geostationary synchronous orbit are part of the territory over which equatorial states exercise their national sovereignty. The geostationary orbit is a scarce natural resource, whose importance and value increase rapidly together with the development of space technology and the growing need for communication; therefore, the equatorial countries meeting in Bogota have decided to proclaim and defend, on behalf of their peoples, the existence of their sovereignty over this natural resource."

The equatorial nations have cited Resolution 2692 (XXV) of the United Nations General Assembly entitled "permanent sovereignty over the natural resources of developing countries and expansion of internal accumulation sources for economic developments," as a basis for their claim, as well as Resolution 3281 (XXIX), Article 2, sub-paragraph i, which reads: "All states have and freely exercise full and permanent sovereignty, including possession, use and disposal of all their wealth, natural resources and economic activities."

While the Equatorial nations will "not object to the free orbital transit of satellites approved and authorized by the International Telecommunications Convention, when these satellites pass through their outer space. . . outside their geostationary orbit," they have decided that "the devices to be placed permanently on the segment of a geostationary orbit of an equatorial state shall require previous and expressed authorization on the part of the concerned state, and the operation of the device should conform with the national law of that territorial country over which it is based."

The equatorial nations have dismissed the Treaty of 1976 on "The Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," saying that "There is no valid or satisfactory definition of outer space that may be advanced to support the argument that geostationary orbit is included in the outer space," adding that "what was actually developed was technological partition of the orbit, which is simply a national appropriation, and this must be denounced by the equatorial countries.

Needless to say, this development could cause some complications for communications and solar power satellites!

UN DIGNITARY ON POWERSATS, SPACE SETTLEMENTS

Based on an interview conducted by Elaine Meinel in New York on February 2, 1977, with the Austrian Ambassador, Herr Jankowitsch. Chairman of the UN Committee on the Peaceful Uses of Outer Space.

In our anxiety to persuade the United States government to support an active space program, we tend to forget the international implications and legal entanglements such a program creates. The UN Committee on the Peaceful Uses of Outer Space was first formed in 1957 after the Soviet Union launched the first sputnik. In 1967 a Space Treaty was ratified by the General Assembly. It was a rather general document which states, in essence, "The use of outer space shall be for the benefit of all nations, irrespective to the stage of their development and shall be the province of all mankind . . . no nation may engage in orbital military activity, nor shall any nation engage in environmentally detrimental activity, and that all participating nations shall keep the UN Secretary General informed as to all space activities and plans."

So far, the Committee on the Peaceful Uses of Space has had a low profile since there has been little activity of a commercial nature in space outside of communication satellites so the tension and controversy which has created difficulties for the Sea Treaty has not yet characterized sessions dealing with Space Treaties. Realizing the old treaty was insufficient for dealing with recent advances in space technology, the Committee is presently attempting to draft a new Moon Treaty which, because it is very similar to certain aspects of the Sea Treaty, will not be sent out of committee until the Sea Treaty is completed, which may be sometime in 1980.

Just as much of the resources hidden under the ocean are effectively out of the reach of the developing nations, so to even a greater degree, the Moon's resources are beyond their grasp. Ambassador Jankowitsch pointed out that the establishment of space colonies would really raise a number of problems since the construction of such facilities would be the equivalent of establishing a national territory in space. Already the countries which lie on the equator have held a meeting in December in Bogota, Colombia, where they decided that any artifact, regardless of use, which is set in a geosynchronous orbit over their national boundaries is within their jurisdiction so they may decide what orbits where and perhaps charge rent or whatever for the privilege of using these orbits. Ambassador Jankowitsch had no comment as to how the committee shall deal with this proposition, but he is confident it will not prove to be a stumbling block for the new Outer Space Treaty.

Not that we can ignore the needs of the Third World, cautions the Ambassador. After all, the industrialized nations have greatly depleted most of the easily accessible resources to fuel the development of their economies, leaving little behind for the newer emerging nations. Today it requires great skill and technological know-how to reach and use the same materials and this is beyond the abilities of the Third World, so if countries such as the US, even if they are working on an international basis with, say, Austria or Japan, were to mine the Moon, there would have to be a way for these other nations to get into the act.

One other thing the Committee is doing which touches upon the subject of trying to help developing nations is to encourage the development of solar energy. The Chairman first heard of the L-5 Society because it supports the development of Satellite Solar Power Stations and he hopes that this power will be available for his own country, Austria. But because the technology behind the SSPS is so advanced, it would be difficult for the developing nations to use, so his committee has been encouraging the development of solar energy plants which could power villages and such. Although the UN Committee cannot fund such projects, it may prove to be instrumental in encouraging the richer nations such as Saudi Arabia to underwrite research for this project.

Most of all, Ambassador Jankowitsch would like to see space colonies some day because then his committee shall have a lot to do!

SOVIET MISSION CUT SHORT

James Oberg

The manned portion of the Salyut-5 mission appears to have ended with the unexpectedly brief Soyuz-24 visit in February. Although observers had expected cosmonauts Gorbatko and Glazkov to remain in space for at least two months, they returned to Earth after only 18 days in orbit.

Persistent reports of atmospheric contamination (unexpected outgassing?) in Salyut-5 claim that the first crew last July-August had to cut short their flight by several weeks after an "acrid odor" developed inside the Salyut. While unconfirmed, the report does explain several puzzling features of the Soyuz-24 mission (apparently a duplicate of the Soyuz-23 attempt which last October failed to reach the Salyut).

The crewmen did not board the Salyut for half a day after docking, an unprecedented delay. They later dumped air tanks and purged the entire atmosphere of the Salyut.

While on board, the cosmonauts concentrated on zero-G processing experiments, Earth photography, and medical checks. They made further tests of two systems vital for long flights: a water recovery system and an inertial attitude control system which uses not flywheels but a single two-foot diameter 200 lb steel globe spinning in a magnetic field. Varying the spin rate induces torques in the Salyut.

PROSPECTUS

1977 Ames Summer Study on Space Settlements and Industrialization Using Non-Terrestrial Materials

June 22 to August 2, 1977

The study will consider the economic and technical feasibility of construction of manufacturing facilities and settlements in space using non-terrestrial resources. Detailed studies will be performed in several key technological areas. Parallel with these systems studies, comprehensive plans will be developed for the orderly implementation of future research and development activities to support the industrialization of space.

Study Topics

Space Settlement Systems
Technical Study

1. Closed Ecological Systems:

Regenerative life support systems pose some of the most serious design requirements for space settlements. Variables such as cost, total size, number and types of species, length of the food chains, and degree of closure will be considered. This detailed examination of ecological design requirements and their solutions will be incorporated into a long range plan for R&D activities in this area.

2. Environmental Parameters:

This study will examine the impact on habitat design of departing from Earth-ideal human requirements. Within certain limits, human beings can adapt well to changes in environmental characteristics; these adaptations are physiological, behavioral and sociological. A corresponding modification in the specifications for environmental parameters might lead to designs perhaps less costly and more reliable than normal terrestrial conditions.

3. Asteroid Resources:

An investigation of search techniques, remote compositional analysis, orbit determination, and retrieval modes for low velocity increment (relative to Earth) asteroids will be performed. Emphasis will be on the study of optimized transfer of asteroids to Earth parking orbits. Cost effectiveness will be determined relative to asteroid orbit, ΔV, transfer time, asteroid mass, recovered mass, asteroid composition, and mission opportunity.

4. Mass Driver Technology:

This study will define the potential of the electromagnetic mass driver as a propulsion system. It will examine the technical and economic feasibility of employing the mass driver concept in a variety of missions and applications, including its use as: lunar tug, orbit-to-orbit transfer, asteroidal tug, station keeping and control, and as a material launching system. Overall technology needs, as well as those peculiar to a given mission, will be defined. The economics of a given application will compared to those of conventional propulsion systems

5. Non-terrestrial Material Extraction and Construction:

A zero-based approach to the development of non-terrestrial resources will be pursued from discovery through structural component manufacturing. The study will identify and assess processes tailored to the unique conditions of space: gravity, vacuum, energy availability, etc. The economics of developing non-terrestrial resources will be compared to that of Earth resources for various missions and applications.

6. Long-Range Program Planning and Development:

This separate study group will develop near and long-range plans for implementation of research and development activities involving space settlements and industrialization using non-terrestrial materials with due consideration to the Agency's priorities and objectives. The planning group will draw on the expertise of the technical group and will consider all areas of impact, including the required technological needs, the identification of long lead-time programs, and the redirection of some current and planned efforts. In summary, the planning effort will define the sequence of events, from our present capabilities to the ultimate realization of manufacturing facilities in space.

Three L-5 members from Tucson (Annita Harlan, H. Keith Henson, and John Phillips) have been selected as members of Topic I: Closed Ecological Systems.

FASST ANSWERS LDEF QUESTIONS

FASST (Forum for the Advancement of Students in Science and Technology) has received a grant from the Universities Space Research Association (USRA) to increase student and faculty awareness of the possibilities for using the Long Duration Exposure Facility (LDEF) for space experimentation. *(See FASST* News, Sept.-Oct., '76, page 9).

The first LDEF is currently scheduled to be carried aboard a NASA Space Shuttle in the early 1980s and is designed to be left in orbit for long periods of space exposure-from six to nine months.

The USRA consulting agreement enables FASST to assist both members and non-members in acquiring information. Contact: FASST/LDEF, 1785 Massachusetts Ave., N.W., Washington, D.C. 20036.

GETAWAY SPACE OFFERED

NASA has formally announced a "self-contained payload" program for flight aboard the Space Shuttle. Termed "getaway specials," the concept involves attaching containers at various points onboard the Shuttle. These containers would house up to 90 kilograms (200 lbs.) of equipment and space experimentation. Cost per container ranges from $3,000 to $10,000.

The containers are perfect for student space experiments and, in fact, two such containers have been purchased for just that purpose. R. Gilbert Moore, General Manager of Thiokol in Ogden, Utah, purchased one container for $10,000 and offered half of his payload space to the Utah State University for student use.

Dr. L.R. Megill, Chairman of the Space Science Experiment Committee at Utah State will fund a $3,000 payload as a follow-on to Moore's. Under his direction, the available payload space will be offered to high school and college students who submit winning proposals to fly their own experiments. Selected students would be given tuition waivers at Utah State and have the opportunity to earn additional money by working with faculty members involved in space sciences. It is hoped other colleges and universities will consider such programs.

For those wishing additional material on the Utah program write: Dr. L.R. Megill, Chairman, Space Science Experiment Committee, UMC 41, Utah State University, Logan, Utah 84322.

News from ERDA

ENERGY PROJECTS

The following is a list of Faculty Development Projects in Energy sponsored by the Office of University Programs, Energy Research and Development Administration, Washington, DC 20545:

Host Institution	Director	Project Title	Amount
Alabama A & M University, Normal, Alabama 35762	Dr. S.S. R. Murty Solar Energy Task Force	A Faculty Institute on an Introduction to Practical Energy Systems	$ 14,500
University of Alaska Anchorage, Alaska 99504	Dr. George A. Geistauts School of Business and Public Administration	Energy Development-The Alaska Case	20,000
California State College -- Sonoma Rohnert Park, California 94928	Dr. Curtis K. Kjeldeen Department of Biology	A Short Course Entitled “Geothermal Energy and the Environment”	15,400
Florida State University Tallahassee, Florida 32306	Dr. Rodney F. Allen, Department of Science and Human Affairs	Implementing Energy Education in Florida’s High Schools	16,604
Georgia Institute of Technology	Dr. Frank J. Clarke College of Architecture	Energy Conservation for Teachers	16,250
University of Florida Gainesville, Florida 32611	Dr. Edward E. Carrolls, Jr., Department of Nuclear Engineering Sciences	Nuclear Power Generation and the Environment	14,400
University of Idaho Moscow, Idaho 83843	Dr. Robert J. Kearney Department of Physics	Energy and the Northwest	16,998
Southern Illinois University Carbondale, Illinois 62901	Dr. David L. Jones Department of Geography	Faculty Institute on Energy	15,849
University of Notre Dame Notre Dame, Indiana 46556	Dr. John W. Lucey, Department of Aerospace and Mechanical Engineering	Workshop on Electric Power Generation Comparative Risks and Benefits	11,532
Kansas State University Manhattan, Kansas 66506	Dr. J. Kenneth Shultis, Department of Nuclear Engineering	Perspectives in Energy; 1977	12,700
Harvard University Cambridge, Massachusetts 02138	Dr. Paul L. Fishman Graduate School of Design	Solar Energy Short Course	17,947
University of Missouri Columbia, Missouri 65201	Dr. Walter Meyer Department of Nuclear Engineering	Summer Workshop on Electrical Power Generation-Comparative Risks and Benefits	13,849
University of Nebraska Lincoln, Nebraska 68588	Dr. Donald W. McCurdy, Department of Secondary Education	University of Nebraska Energy Education Project	17,445
S.U.N.Y. at Stony Brook Stony Brook, New York 11794	Dr. T. Owen Carroll Institute for Energy Research	Three Week Teaching Seminar	27,286
North Carolina State University Raleigh, North Carolina 27607	Dr. Jerome Kohl, Department of Nuclear Engineering	Workshop on Energy Resources and Electrical Power Generation	11,192
Minot State College Minot, North Dakota 58701	Dr. Clark Markell Department of Science Education	Alternative Technologies Available for the Development of Northern Great Plains Coal Resources	15,274
Miami University Oxford, Ohio 45056	Dr. Joseph Priest Department of Physics	Energy for an Industrial Society: Principles, Problems, Alternatives	11,774
Ohio State University Columbus, Ohio 43210	Dr. Donald D. Glower, Dr. Herbert L. Coon College of Engineering	Energy Resources and Electric Power Generation: A Workshop on Background and Fundamentals of Energy Resources Energy Conversion Processes. Plant Design & Comparative Risk and Benefits	12,500
University of Oklahoma Norman, Oklahoma 73037	Dr. Donald Menzie, Department of Petroleum and Geological Engineering	Faculty Development Seminar on Conventional Energy Sources	14,445
Portland State University Portland, Oregon 97207	Dr. George A. Tsongas, Department of Engineering and Applied; Dr. Michael Fiasca Department of Science Education	Energy Institute for High School Teachers	12,015
University of Tennessee Martin, Tennessee 38238	Dr. David S. Loebbaka, Department of Geosciences and Physics	Energy Resources	6,006
Texas Tech University Lubbock, Texas 79409	Dr. Thomas J. O’Brien Department of Chemistry	Faculty Institute for High School Science Teachers	14,355
University of Utah Salt Lake City, Utah 84112	Dr. Gary M. Sandquist Department of Mechanical Engineering	Energy Conservation	9,560
University of Wisconsin Madison, Wisconsin 53706	Dr. Max W. Carbon Department of Nuclear Engineering	Energy Resources and Electrical Power Generation-Comparative Risks and Benefits	11,550
University of Wyoming Laramie, Wyoming 82071	Dr. R. Beiswenger Department of Geography	Summer Institute in Energy for High School and Junior College Science and Social Studies Teachers	18,250

TOTAL: 25 programs

TOTAL: $367,681

AT&T ZEROES IN ON SATELLITE COMPETITION

Carolyn Henson

Satellite Business Systems (SBS), owned in equal shares by COMSAT, IBM, and Aetna Life and Casualty, was formed on December 15, 1975. They plan to use 12/14-GHz frequency bands, small Earth stations, and time-division (as opposed to frequency division) access to the satellites' transponder channels. Advantages of SBS's approach are the ability to provide multiple circuit connections with the same ease as single circuits, allowing millions of bits per second connections as easily as hundreds of bits per second connections; accelerated facsimile transmission speeds; less expensive teleconferencing; and decreased likelihood of frequency interference (due to the use of 12/14-GHz frequencies).

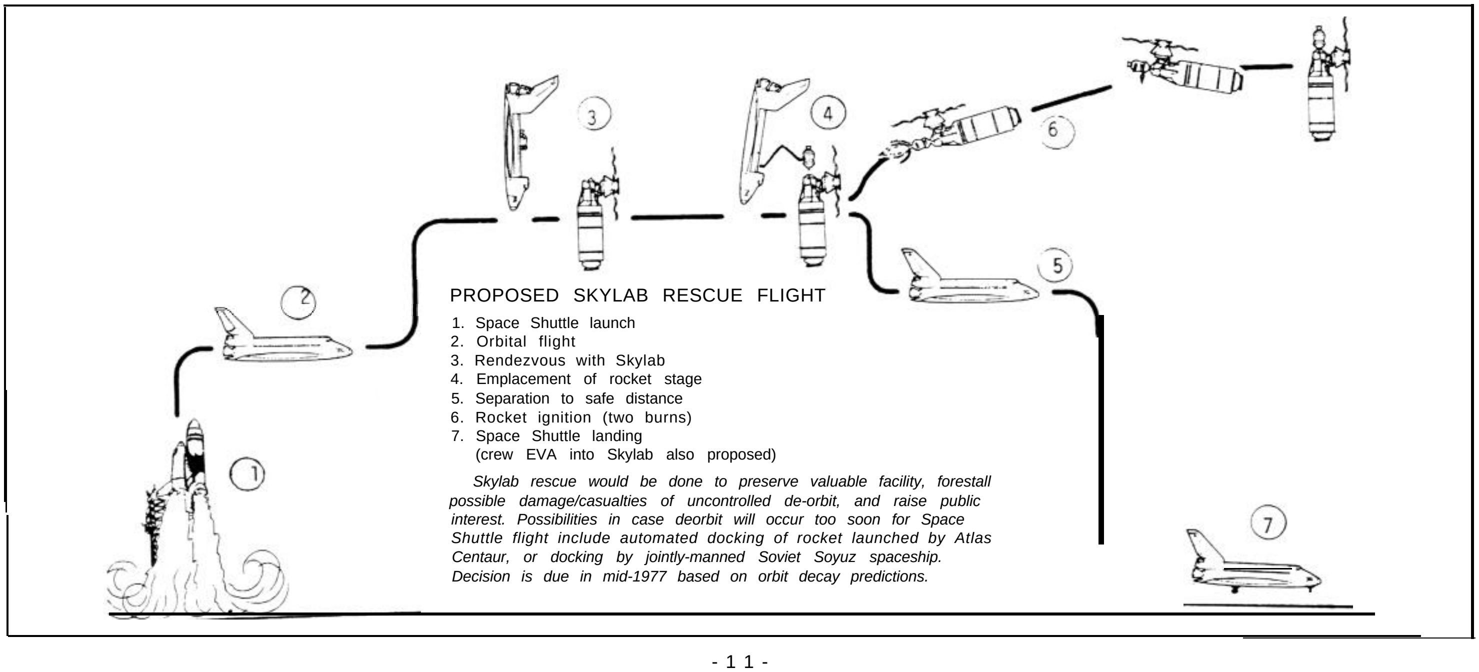
AT&T is striking back at her fledgling competition, but not by offering comparably cheap services! AT&T lobbyists have filed in opposition to SBS's application before the Federal Communications Commission, and just in case that move fails, have begun lobbying for passage of the "Consumer Communications Reform Act."

Columnist Jack Anderson has said of this bill:

> ATT executives have been lobbying on Capitol Hill to gain favor for a "Consumer Communications Reform Act." Actually, the bill has nothing to do with consumer reforms. On the contrary, if passed into law, the act would effectively eliminate all competition within the industry.
>
> But three courageous congressmen have decided to take on "Ma Bell." They are Richard Ottinger of New York, Charles Whalen of Ohio and Tim Wirth of Colorado. They have prepared a tough resolution to replace ATT's.
>
> The congressmen's proposed act says in part, "Competition in the tele-communications industry should be permitted wherever such competition serves the public." The two bills should give Congress a clear choice between a monopolized telephone system and a free-enterprise system benefitting the public.

The *IEEE Spectrum,* January 1977, in a news report on "Technology and Society," reports:

> The question that arises in the mind of at least one observer is why the communications giant should be concerned with SBS. Some might conclude that, beneath the surface, AT&T sees SBS as potential competition and, significantly, it is such unwanted competition that prompted AT&T to press for the passage of the "Consumer Communications Reform Act of 1976" -- potentially the most significant piece of legislation on communications in decades. Commonly known as the "Bell bill," this proposed legislation had been endorsed by 179 members of Congress at last count, and reports in the popular press have suggested that AT&T may be spending as much as $100 million to lobby the bill through Congress. There is neither time nor space to go into the details of the controversy surrounding this proposed legislation, but suffice it to say that AT&T's basic premise is that continued competition for existing services will degrade telephone network and increase the cost of basic telephone service by "skimming the cream off the top" of AT&T's most profitable services. According to AT&T, the bill "in no way intends to eliminate competition for innovative services." To the degree that SBS's proposal allows potential industry and Government customers to communicate outside the aegis of the Bell System, the SBS concept could represent outside competition-but would SBS's service be innovative or duplicative?
>
> To many in the communications industry, however, that question is moot. Rather, they argue that the Consumer Communications Reform Act and its sponsor, AT&T, would effectively crush competition for innovative services (a view espoused by SBS) as well as existing services-the crux of the debate. AT&T opponents go on to argue that AT&T is pressing for de facto nationalization of the communications industry, thereby stifling "a robust, innovative sector of our economy and denying forever a competitive marketplace," to use the words of John Eger, former acting director of the White House Office of Telecommunication Policy. In fact, Eger has argued : "The lines between our data-processing and communications technologies are blurring, and AT&T knows that the telephone business of today and the communications business of tomorrow are vastly different.
>
> "Already AT&T is providing services that employ stored programming techniques and other data-processing innovations. There is also a $35 billion industry made up of hundreds of companies whose business is to manufacture computers and other related business equipment, as well as to provide so-called software and programming services." The implication, of course, raises the question : why should AT&T be permitted to monopolize in one area and compete in another?
>
> This question was addressed directly by SBS president Philip N. Whittaker in testimony before the Subcommittee on Communications of the House Committee on Interstate and Foreign Commerce on September 29. Said Mr. Whittaker: "Reduced to its simplest terms, the only possible purpose for, and the certain consequence of, the enactment of this legislation would be to grant an absolute monopoly to AT&T in all commercial communications excepting record and broadcast communications. Users of telecommunications services would be tied to a sole source. They would be locked into AT&T's decisions regarding what facilities and what technologies should be used to provide what services, when and at what prices. To make matters worse, AT&T, by this legislation, would be virtually unregulatable in its decision making."
>
> This debate is simmering during the current Congressional recess but it should boil over during 1977. Whether passage of the Bell bill will crush SBS -- as company spokesmen claim and AT&T denies -- remains to be seen. But, at the same time, SBS must fight off objections from a very different quarter. Ironically, while IBM, as a partner in SBS, lines up as an opponent to the specter of an AT&T communications monopoly, it itself is being attacked as a monopolist of the data-processing industry. Several IBM competitors feel that IBM could strangle competition by virtue of its partnership in SBS. A typical question is : would IBM provide below-cost business machines to SBS customers, thus washing out any losses in that sector by profits gained via SBS? Queried by Spectrum, IBM representatives vigorously denied such charges, labeling them "preposterous." And, in addition, in its FCC filing, SBS claims that IBM will not indulge in such practices. Nevertheless, doubts remain in the minds of its competitors who, along with AT&T but for different reasons, have filed in opposition to SBS before the FCC.
>
> Here we have nothing less than a morass of claims and counterclaims that will be resolved by an essentially political -- not technical -- decision-making process; whether that resolution will benefit or hinder technology is not known. But it is certain to alter the sociotechnical landscape.



PROPOSED SKYLAB RESCUE FLIGHT

1. Space Shuttle launch
2. Orbital flight
3. Rendezvous with Skylab
4. Emplacement of rocket stage
5. Separation to safe distance
6. Rocket ignition (two burns)
7. Space Shuttle landing
   (crew EVA into Skylab also proposed)

Skylab rescue would be done to preserve valuable facility, forestall possible damage/casualties of uncontrolled de-orbit, and raise public interest. Possibilities in case deorbit will occur too soon for Space Shuttle flight include automated docking of rocket launched by Atlas Centaur, or docking by jointly-manned Soviet Soyuz spaceship. Decision is due in mid-1977 based on orbit decay predictions.

SPACE PHOTO ALBUM OF THE WORLD AVAILABLE

The most comprehensive and detailed "space photo album" of the world's natural and cultural features has been prepared with images from NASA's Landsat Earth Resources satellite by Nicholas M. Short, Paul D. Lowman, Jr., and Stanley C. Freden of NASA's Goddard Space Flight Center, and Dr. William A. Finch, Jr., of the San Diego State University. Entitled *Mission to Earth: Landsat Views the World,* the atlas size publication contains some 400 Landsat images, most of them in color and close to full-page size. It is available through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $14. The stock number is 033-000-00659-4.

Because of the value of the book to educators, an Educator's Guide is being prepared by the Goddard Center, and will be available at no cost upon request to the Center's Office of Public Affairs, Educational Programs, Greenbelt, MD 20771. The guide contains a "Teacher's Resource Section" which includes classroom activities, exercises and techniques for using the imagery. To facilitate the use of *Mission to Earth,* the guide includes a glossary of geological and remote sensing terms used in the book.

(Continued from page 3)

reality. They do not pay particular attention to whether this or that space industrialization idea (SSPS, pharmaceutical production, etc.) is immediately cost-effective or not. What matters to them is that these ideas are coming up, and in increasing frequency. They believe that once one of these becomes a reality it will mean factories will be established in orbit and that these in turn will then beget other useful ideas for the utilization of space. There will be a multiplying effect that will move rapidly enough to leave analysis of the full social, political and economic impact of space industrialization lagging. To avoid this situation academicians want to start their analysis now. They seem objective toward the benefits and liabilities of technological advance, recognizing that it must be continuously shaped by an ongoing assessment of its potential impact from the point of view of the social sciences and humanities. They add to this a sense of hope that we can indeed come to terms with this planet, at least in part through the careful utilization of space for future industrial growth.

Old timers in the L-5 Society will remember Dr. T. Stephen Cheston. He keeps track of things legislative and administrative for O'Neill. If you are passing through Washington to say hi to your representatives (and to tell them what you think of these new space ventures) give Cheston a call.

EUROPEAN CONFERENCE

L-5 Society, West European Branch, announces a European Conference on Space Settlements and Space Industries, to be held September 20, 1977, at Queen Mary College, University of London, U.K. The Society is sponsoring this conference in order to provide a European platform to discuss and review the state-of-art in concepts, designs and studies of space settlements and space industries. Topics may range from small initial space stations up to large space colonies and from small shuttle-based space manufacturing techniques through to large space-based solar power station concepts.

Papers may consider-but are not limited to-the following topics: materials resources; large space structures; on-orbit space transports; industrial operations in space; system analyses; Earth-to-orbit systems; space community planning; satellite solar power stations; space law; European interests in large-scale space operations; low-cost structures; economics of space-based industries; space manufacturing techniques.

Prospective authors are invited to submit papers on the above and other relevant topics for consideration for presentation at this conference. The selection of papers will be based on summary papers of 300-500 words which must be received at the address below by May 31, 1977. Authors will be notified of acceptance by June 28. Complete manuscripts must be received by August 10.

Attendance at the conference will be limited and all persons wishing to attend and to receive further information should write to: The Director, L-5 Society (WE), 40 Lamb Street, Kidsgrove, Stoke-on-Trent, ST7 4AI. England, U.K.

Ready for rescue-Dr. Timothy Leary at the controls in the SKYLAB in Houston (see SKYLAB Rescue, page 11).

Inside the L-5 Society

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FROM THE L-5 OFFICE

Next Month --

The Society has been accumulating some long but excellent articles-too long for the News but too good not to publish. So, next month we will put out a long issue and the month after cut back to a short (8-10 pages) issue. If this works out well, we may make every third issue a long one (with maybe even a color cover!). Also, the post office informed us that sample copies cannot be mailed at third class rates, so you can expect a brochure in the near future.

Late Flash --

The floodgates are opening on Space Habitat books. T.A. Heppenheimer, well-known to *L-5 News* readers for his lively writing style ("Home, Home on LaGrange" in the August 1976 issue of the *L-5 News,* and many others) has authored a lavishly illustrated book, *Colonies in Space.* There are a number of color plates and over one hundred black and white illustrations. Some of the text is familiar sounding, but Heppenheimer has freely acknowledged the contributions of others in the field.

- *Colonies in Space,* T.A. Heppenheimer, Stackpole Books, 1977. $12.95.

Available from the L-5 Society for $12.00 plus the $1 handling charge.

Energetic Response --

The Society received a request for input from the federal Energy Policy and Planning Off ice on Tuesday, March 8. Our reply (see opposite page, *Dear Dr. Schlesinger. . .*) and a copy of the request were mailed to members of the Society on Thursday, March 10.

Dear Dr. Schlesinger;

Solar energy, while practical for heating and perhaps cooling, is commonly excluded from consideration for supply of our major electric power needs because of the problems of energy storage for periods of darkness and overcast weather conditions.

One way of tapping solar energy which avoids the problems of night and clouds is to collect it in space and beam the energy to Earth by microwave. This would provide a reliable, non-depleting, non-polluting long-term source of energy for all forms of use.

Methods for collecting sunlight in space and transmitting large amounts of energy to the surface of the Earth have been worked out in detail by groups at Arthur D. Little, Inc., and Boeing Company. The remaining problem is the economics of lifting the power plants off the Earth. To bypass this difficulty. it has been seriously proposed (Science, December 5. 1975) that an industrial base be established in space to construct solar power satellites (SPS). mostly utilizing materials extracted from lunar soil.

Careful economic analyses indicate that this method could supply energy at a fraction of current or projected cost for fossil or nuclear power. The original estimates for the cost and time for establishing an SPS construction base were about $200 billion and 20 years. However, recent studies of more effective methods indicate that the cost might be reduced to $20 to $30 billion and the time to six or seven years after the Space Shuttle is available (about 1980). After this point (about 1987), several percent per year of our energy needs could be shifted to this form of solar energy.

In being considered as a major source for energy, this plan suffers mostly from newness and, of course, from competition with well-entrenched interests in industry and the federal bureaucracy.

As you have asked for suggestions, here are mine:

(1) Complete without delay the Space Shuttle. It is the key to space industrialization.

(2) Support the SPS studies and development. Funding for these activities was largely lost in a recent NASA/ERDA jurisdictional squabble,

(3) Ask NASA to request funds for a line item ($ 100-200 million) in the budget, for space industrialization studies. This was dropped from the current budget to avoid starting a new program under the previous administration.

A conference on space manufacturing facilities, partly sponsored by NASA and ERDA, is being held at Princeton University, May 9-12. You or your staff would no doubt be welcome.

Sincerely yours,

H. Keith Henson
President, L-5 Society

c.c. Members of L-5 Society

THE L-5 LOCAL CHAPTER

The L-5 Society is both a national (and international) network acting as a clearinghouse for information on space colonization and space solar power, and a collection of local chapters devoted to publicizing and advancing these issues. It is not necessary to belong to a local group to belong to the L-5 Society nationally, nor vice versa. However, if you now wish to join a local chapter, we can direct you to one. Since there are not yet many local chapters in existence, there may not be a group convenient to you. In that case, don't despair, organize one yourself! It's easier than you might think.

If you have ever been active in any kind of organization, whether political, fraternal, church, or any other sort, much of the following advice will be things you already know about. But even if you have never done anything like it before, don't be deterred. A little effort on your part may bring surprising results.

First, we can help you by sending written material and slides, and by putting a notice in the *L-5 News* that you are interested in forming a local chapter in your area (you may want to get a post office box to protect your privacy).

If you get in touch with other local L-5 members, get together and form the nucleus of a local chapter right then and there, figure out what your resources are and how much you want to do, and get started.

Some sample activities are as follows: holding public meetings (especially at schools and universities) to explain the L-5 idea, giving talks to existing groups to which you or your friends belong on the L-5 concept, bringing in speakers to give a lecture and slide show on L-5 (write or call us in Tucson if you are interested in this), appearing on local radio or TV talk shows and explaining the L-5 idea, writing letters to papers to answer criticisms of space travel, and proposing space solar power whenever energy issues are being discussed (especially when a dispute arises over building a nuclear power plant or a new coal strip mine near your town).

Some things to remember are

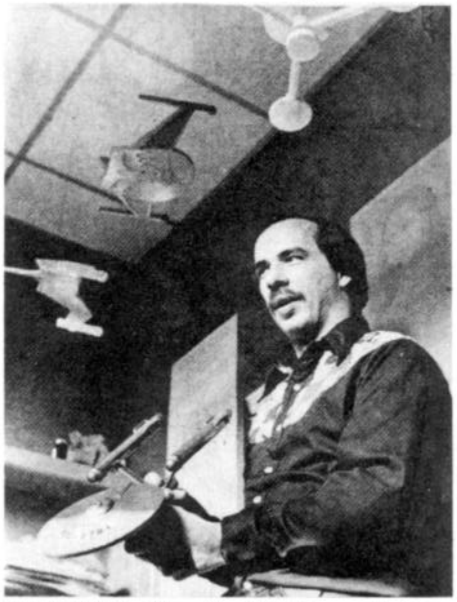
1. Don't attempt more than you are comfortable with. If you don't feel you can give a good talk in the lecture format, don't try. Just sit around a table and discuss the idea, and pass around some *L-5 News* or a copy of *The High Frontier,* or Xeroxes of some of the good magazine articles that have appeared.
2. When you meet interested strangers, get their name, address, and phone number, and make sure they are invited to every event you hold. Keep an accurate, up-to-date contact list, and don't give it out to anyone else (respect their privacy!).
3. L-5 is not a political party, nor a church. We have no "party line," we do not endorse (or oppose) candidates for office, we do not push a specific political or economic system. We just want to get into space! Try to get along with other L-5ers even if you are opposites in politics, lifestyle, hair length, or other trivia. Avoid cliques or "old guards" dominating the group.
4. Good places to spread L-5 information are universities and colleges, secondary schools, and science-fiction gatherings.

If you are a student-see about getting your L-5 chapter recognized as a student organization, then go to the Office of Student Organizations, or whatever it's called on your campus, and find out what help you can get. Usually you can get free or cheap meeting rooms, an office, access to mimeograph or printing. Sometimes they even put up money to bring speakers to campus. And remember, student newspapers and radio stations are always hard up for copy. If you have an article or a program format ready, they will probably be overjoyed to use it.

This is by no means a complete list or strict guidelines. Above all, stay in touch with us in Tucson, tell us your problems and your triumphs and we can all learn something.

Jim Bennett

San Marcos Daily Record



DISPLAYING SOME miniature replicas of futuristic space craft and space stations, local L-5 Society organizer Troy Welch explaines the advantages of colonizing space in the near future. He says massive enclosed space colonies could provide an alternative to Earth living as well as supply badly needed solar power. The L-5 Society is dedicated to spreading the word and gathering support for space colonization.

LOCAL PUBLICITY

The San Marcos L-5 Chapter made the front page of their local newspaper, *The San Marcos Daily Record,* recently. How did Troy Welch manage it? We suggest writing him c/o Physics Department, Southwest Texas State University, San Marcos, TX 78666 for hints on local publicity.

Another red-hot society publicist is Mike Shields, who arranged two major lectures and two television appearances for L-5 spokespeople in San Diego this March. For details on how he does it, write to 695 Nardo Avenue, No. G-8, Solana Beach, CA 92075.

L-5 ON TEXAS TV

The L-5 Society has some enterprising and resourceful members. One of the best is Dr. Harlan Smith, Director of the Department of Astronomy at the University of Texas at Austin. Dr. Smith and his colleague, Dr. Alex Dessler, professor in space physics and astronomy at Rice University, were featured on an hour-long documentary, "The High Frontier," on KPRC-TV in Houston, March 9. The writeup we received about the show (sponsored by Fannin Bank) went this way:

> Two noted scientists predict how we will solve the energy crisis by collecting solar energy in space and transmitting it to Earth via microwaves, how man will create "planets" of his own orbiting the Earth, what the human race can expect for the next 200 years.
>
> More than interesting-valuable family viewing.
>
> "This is a fantastic special that everyone should see." --C.W. Skipper, TV Editor, Houston Post.

Small wonder the Texas membership is so large.

WHAT'S AVAILABLE FROM THE L-5 SOCIETY?

- Xerographic reproductions of articles from other publications (please ask for list).
- *The Hunger of Eve: A Woman's Odyssey Toward the Future,* Barbara Marx Hubbard, Stackpole Books, 1976. $8.00.
- *The High Frontier: Human Colonies in Space,* Gerard K. O'Neill, Wm. Morrow and Co., 1977. $8.00.
- *The Fourth Kingdom,* William J. Sauber, Aquari Corp., 1975. $6.
- *L-5 News,* back issues $1 each (Volume 1 included 16 issues).
- Bernal Sphere color postcards (interior, exterior). 15¢ each; 50 of one kind, $3.
- Bernal Sphere 14" x 17" color posters (interior, exterior). $2 each.
- Introduction to the L-5 Concept, 18 slides, $9.
- Space Industrialization, 28 slides, $14.
- Satellite Solar Power Stations, 12 slides, $6.
- Space Habitats, 18 slides, $9.
- The L-5 Society Slide Show, all 76 slides, $38.
- Individual slides, 50¢ each. Write for catalog.

Note: Postage and handling per order, add $1. Prices subject to change without notice. Wholesale pricing available on some items. Write for details.

ANOTHER UNIVERSITY SPACE STUDY GROUP FORMED

A student-faculty group has been formed at the University of Arizona to study space habitation and industrialization. The primary goal of the group is to take advantage of talent present at the university to solve problems regarding construction of an industrial base in space. Other goals range from defining the technical aspects of constructing large structures and refining lunar materials, to the social, political, and economic aspects of such a project.

Another equally important area for work is to increase public knowledge about the benefits of expanding into space. To fulfill this goal, the group will sponsor a series of films and slide shows on the campus.

The group is affiliated with the L-5 Society. Stewart Nozette, president of the Tucson L-5 Chapter, is also president of the study group. Those who wish to contact this group can write to Stewart Nozette, c/o The Lunar Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

Letters

A small contest. I'm doing a book (with Rick Sternbach) for St. Martin's Press on space colonization/space industrialization. Having a hell of a time with the title. I wanted to call it *Space to Grow In,* but the editor doesn't like it-not snappy enough (I have to agree.) Said editor wants to call it *The Final Frontier,* which I don't like for several reasons, not the least being that it sounds like a rip-off from O'Neill's book.

So if anybody can come up with a title that suits both me and the editor, she-he-it will win ten glorious bucks and an autographed copy of the book. Earliest postmark, etc. Offer void where prohibited by law. Employees of St. Martin's Press or the author must disguise their identity. Send your title to Joe W. Haldeman, Box 855, Iowa City, IA 52240.

I would like to make a few comments on the article "Space Research and the Military," excerpted from *Skeptic* no. 17, in the February L-5 News

a) The passages printed contain some statements which I believe are factually incorrect, or at least misleading. The most important example is that to the best of my present knowledge and belief, the United States does not include, nor seriously contemplate including, a first strike plan as a part of our military policy or strategy. There may be some officers, or even some civilian officials of the Defense Department, who might *wish* we had such a policy, but it is my understanding that such individuals have been thus far successfully restrained by administration leaders who have considered (and I believe correctly) that such a policy would have a destabilizing effect and add fuel to the arms race. I can't speak for the Soviets; maybe they do have first-strike plans. But I seriously doubt that we do.

b) A nation with a laser-equipped powersat can deny access to space to anyone else? Only if the same outfit manages to have two or more such satellites ready simultaneously, and before anyone else does. With only one, how does it prevent launches from the opposite hemisphere?

c) Could not the power-sat project be put under international control, with inspections to insure that no one installs weapon-grade lasers on them?

d) If we've got to have weapons around, I'd much rather they be precise, selective, surgical tools like lasers than indiscriminately destructive nuclear bombs.

e) If people are inevitably going to be belligerent, as the article seems to suggest, and if military services are inevitably going to acquire every weapons system they can, do you suppose we are safer if we remain earthbound? One of the reasons for getting large numbers of people into space is that it will reduce the likelihood that any one disaster, natural or man-made, can simultaneously wreck all of humanity. Or to put it in the words Jerry Pournelle used in the December Galaxy, "We won't *have* to have outgrown our damn foolishness to insure our survival as a species."

Larry Friesen
Webster, Texas

This is a response to John Holt's attack on space research, on the grounds of the potential resultant hazards to humanity. In reality, such research and development can not substantially increase the existing probability of large-scale violence. The existing weaponry deployed by most of the world's governments and some other organizations, including biological, thermonuclear and "conventional" weapons, already offers an enormous overkill factor-use of less than one tenth of it could virtually extinguish life on this planet. Additional weapons, no matter how spectacular, can only add very small increments of risk.

The use of L-5 satellites to provide massive new energy resources for Earth could substantially *reduce* the risk of world war, if a fair share of the new energy is made available to the Third World. If the major industrial nations fail to deal with the needs of the Third World, the probability of war will steadily increase. History provides abundant examples of civilizations with relatively advanced technology being overwhelmed by "barbarians," and messianic leaders usually believe that they have nothing to lose and everything to gain. The well-being and perhaps even the survival of the industrial nations depends on their willingness to use space research and other forms of high technology to establish an acceptable quality of life, or better, for everyone on the planet.

The question of whether or not to design and construct sophisticated weapons is completely out of our hands. Such matters are decided by governments, and a referendum or specific mandate in this context is exceedingly rare. Historical comparisons suggest that weapons procurement people of several nations are already deeply involved with preparations for warfare in space. This is not a doomsday prediction that such wars will necessarily take place, but merely a statement that some organizations are in fact doing everything they can to equip themselves for it, and that there is virtually nothing an individual can do about that.

What can be influenced is the peaceful use of space technology. It makes no sense to be negative or apathetic towards it, on the basis of ill-founded fears. Those who see the enormous potential for peaceful and humanistic applications of space research do have the option to support it, and perhaps even the moral obligation to do so.

Paul B. Shewan
Spokane, Washington

Eric Drexler, in L-5 News *No. 14,* points out that "a completely closed ecological (or even agricultural) system" is not a prerequisite for space colonization. Of course, he is right. In fact, *understanding the basis of a fundamental agricultural/ecological system* definitely should not be a prerequisite to the construction of the colonies, because any earth-bound *understanding* necessarily can be only analogous and theoretical without on site data collection. The point is not to disparage the power of reasoning at a distance, but rather to avoid geocentricities during initial development when such misconceptions could be most detrimental.

Considering the anticipated populations of full scale colonies as compared to the size of construction crews, the immediate need for on site photosynthetic carbon recycling is minimal. Since carbon, hydrogen, and the other elemental constituents of life support have to be provided for the full scale colonies and food products (dehydrated) have an appropriate mixture of these elements, it is reasonable to plan for *long range* food supply from earth with "waste materials" being stockpiled.

During this time, on site agricultural research can be initiated in unison with developments in lunar ore processing, environmental controls, shape geometry, etc. Emphasis might first be directed to small scale "kitchen gardens" that intend only to add fresh foods to the highly manipulated food products being shipped from Earth.

The idea of total self-sufficiency in life support systems is very appealing. Indeed, until full scale space farming is a reality, the colonies will remain space stations and cannot be considered true habitats. However, with time, as data and stockpiles accumulate, the opportunity to make better long range design decisions will increase. It should be recognized that total agricultural development is not urgent and need not be hurried.

Pierce Jones
Gainesville, Florida

On the other hand, some research on crop yields needs to be done before a space settlement can even be designed. Cost of a space habitat is area dependent and crop area estimates have varied from 32 to 250 m^2*/person.*

What a perfectly splendid letter you wrote to Dr. Schlesinger on national energy policy, and what a swell job you did in getting the word out to the L-5 membership. I had just written the enclosed [letter to President Carter] when I received your mailing.

If enough of us make a noise, perhaps something may be accomplished.

Frederick H. Osborn, Jr.
Garrison, New York

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NL 704

L-5 SOCIETY
1620 N. PARK AVE.
TUCSON, AZ 85719

NAME: ______________________________

ADDRESS: ______________________________

CITY/STATE/ZIP: ______________________________

AFFILIATION/TITLE OR POSITION: ______________________________
(OPTIONAL)

I am-am not-interested in being active locally. Phone (optional) ______ - ______

Please enroll me as a member of L-5 Society ($20 per year regular, $10 per year for students). A check or money order is enclosed. (Membership includes *L-5 News,* $3 to members; the balance -- $17 or $7 -- is a tax-deductible donation.)

__ Please enter the above as a nonmember *L-5 News* subscriber ($20 per year). A check or purchase order is enclosed.

Enclosed find a donation of $____________. (Donations to L-5 Society are tax-deductible.)

I have *read* a couple of articles about the possibility of having space colonies within the next twenty to thirty years. This really fascinates me and I would like to be a part of this venture when it takes place. I don't think my chances will be very good, though, considering that I will be at least 43 years old, or probably older by the time it becomes reality. I'm not rich, either, another mark against me. And I doubt an experienced coal miner would be much use, either. My wife thinks the idea is crazy. Nevertheless, the idea of living in space attracts me very much. So I would like for you to send me information, or suggestions that might increase my chances in participating in the migration to space.

Stephen Durbin
Corydon, Kentucky

Experienced, hard working people will be needed in space sooner than the rich, and lunar or asteroid mining won't be all that different from coal mining. If you want to help, talk your union into supporting space migration. After all, somebody will have to represent the asteroid miners. And finally, don't despair, the move into space may happen much sooner than we think.

IN THIS ISSUE:

Mining the Asteroids 1
L-5 in Congress 2
Islands in Space 4
Waste Heat Rejection Methods 6
International View 8
News from ERDA 10
Skylab Rescue 11
Inside the L-5 Society 12
Letters 14

Has anybody discussed the mechanics of prospecting for carbonaceous chondrites on the Moon? A crater produced by the infall of a carbonaceous chondritic meteor might be a much more practical source of hydrogen, carbon, and nitrogen than the asteroid belt.

Intuitively it would seem that the material in the vicinity of such a crater would have a different heat capacity than the stuff in a "just-plain-old" crater. Therefore it would cool at a different rate; an orbiting probe with an infrared radiometer would be able to pick it out from its surroundings as darkness fell.

The polar-orbit probe that NASA has scheduled for 1980 might do the trick -- or the data might already be available, from Apollo orbital observations.

It might be, though, that the high temperature generated by the impact of a large meteorite would vaporize the compounds that we're interested in, and so disperse them over an impractically large area. Still worth looking into.

Joe W. Haldeman
Iowa City, Iowa

I temporarily agree with [the] . . . conclusion . . . that it is a waste of time and resources to search for radio messages from other galactic civilizations. The search for other galactic civilizations can only properly and economically be accomplished from outer space, where the Earth's rotation, atmosphere, and sources of light and other radiations do not interfere. The apparent ease of manufacturing the required instruments in outer space, and the availability of virtually unlimited solar energy in outer space to provide the energy required lead me to conclude that other intelligent civilizations will assume we will go to outer space to attempt to receive their messages. So, I conclude that we should wait until we have colonized space before attempting to detect (or transmit) such signals.

Jay S. Huebner
University of North
Florida,
Jacksonville, Florida

[Reprinted from The Physics Teacher]

I have been receiving and reading your newsletter for about half a year, but I have not yet seen an article or letter on/by/about women in the space program. I have applied for one of the Mission Specialist Astronaut positions which are opening up in conjunction with the Space Shuttle and would like to hear from other women who are doing the same.

I haven't met any other applicants in my area. I've also heard that the percentage of women applying is much lower than was expected. How many of us are there?

I am 24, have a joint bachelor's degree from U.C. in biology and chemistry and two years' experience as a research technician aboard a Geological Survey research ship. I'd like to know what kinds of background other people have. Also, has anyone heard from NASA yet? Maybe we can give each other support during the long wait for notification.

I'm sure I'm not the only one doing this and I'd like to get in contact with others.

Clare L. Bell
1649 Alma St.
Palo Alto, Calif. 94301

I'd like to see somebody start real international law studies of the treaties governing exploitation of Antarctica and the sea floor, compared as precedents with treaties in force and in negotiation regarding the Moon and other celestial bodies. Question: could the United Nations block/tax/control the construction of space power systems? Question: what country or countries would not want to see the building of a space power station by the United States, and why not? What means would they use to prevent it, and how could the United States circumvent these means (ranging from diplomatic protests to sabotage to physical assault-including boarding)? Is a solar power station a "weapon of mass destruction" (space treaty)? Somebody, help think about it.

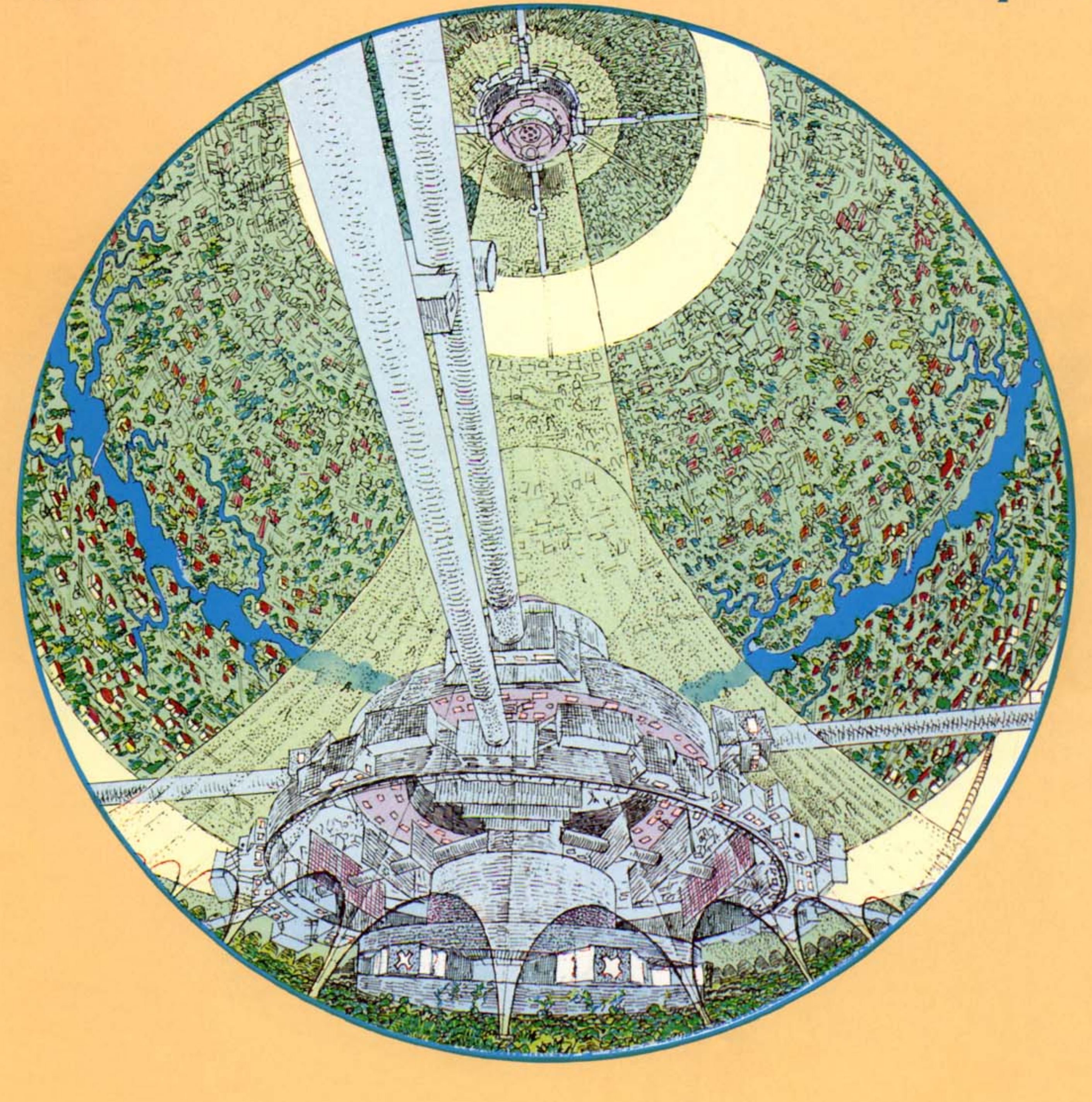
Jim Oberg
Dickinson, Texas

Space Settlement

LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

L-5 News

May 1977



Space Settlement

Special Issue of the *L-5 News*
Volume 2, Number 5 **May, 1977**

Contents:

Developing Space Policy 1
Jack Salmon

Arthur Kantrowitz Proposes A Science Court 4
L-5 interview by Eric Drexler

Boeing Designers Answer Questions About Satellite Solar Power 6
Norie Huddle

Spacelab 10

L-5 in Congress - Part 2 12

What's Available from the L-5 Society? C-l

Bernal Sphere C-2
Don E. Davis, artist

ERDA 21

Inside the L-5 Society 21

Bibliography 22
Jesco von Puttkamer

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Front cover:
BERNAL SPHERE INTERIOR.

A series of concentric buildings and galleries at each end are constructed around the axis of the Bernal Sphere. This fish-eye view is from the edge of the zero-gravity conical safety net which encloses the structures. The foreground area between the windows of the building and the poles that secure the net is wild and overgrown with vegetation. This area is too steep for residences and is not as fully shielded from cosmic rays. The spokes are structural supports with elevators inside (Drawing by Don E. Davis, mechanical color separations by Jonathon Nix).

letters

I would like to comment on Jim Oberg's questions regarding the Moon, in the March *L-5 News.*

He raised the question of environmental effects of the use of a lunar mass-driver, both on the Moon itself and on the regions of space available for use by spacecraft.

Regarding the latter, recent work has made it clear that the lunar-launched mass stream will be very well-defined in its trajectory characteristics, and will be predicted well in advance. Thus, it need pose no more of a hazard to navigation than any other type of space traffic.

Regarding the former, Oberg suggests that the mass-driver could affect the lunar rotation. The mass-driver, in operational use, will exert a force of some 100,000 newtons parallel to the lunar surface, equivalent to a weight of ten tons at the Earth's surface, or of 36,000 tons at the distance of the Moon.

The lunar rotation keeps one side turned towards the Earth. This is not the result of any delicate balance, upset by small continuous forces. Instead, it follows from the distribution of mass within the Moon (to be technical, the ratio of its moments of inertia). It is an extremely stable arrangement. The Moon itself has mass approximately 7.3 x 10^{19} tons, which is, as mentioned, not completely even in its distribution. The unevennesses amount to far more than 36,000 tons, and one result is that the Moon oscillates slightly around this stable equilibrium. These are the so-called physical librations. Yet these oscillations or librations amount to only some two minutes of arc in the lunar rotation, which is so small that it was not even detected till 1838. So I can only suggest that trying to influence the lunar rotation by means of a mass-driver, is like trying to cause an iceberg to topple over by blowing on it.

Oberg also suggests that it might be useful to provide a tenuous lunar atmosphere, so as to facilitate lunar landing, point-to-point transport (as by aircraft), and communication (by means of an ionosphere). The merits of such a proposal are not at all clear.

To begin, the lunar gravity is not all that bad, and in the absence of detailed designs it is difficult to say whether the saving in propellant mass would not be offset through the extra mass required for an aeroshell or heat shield, parachutes, and the like. Compare (for example) the Viking lander to the rather similar Surveyor lunar lander of a decade earlier.

Regarding lunar aircraft in the Oberg atmosphere, one may begin by asking what would happen if the Earth had no atmosphere. As it is, a 747 or other long-range jet takes off with something like half its gross weight consisting of fuel. If there were no atmospheric oxygen, it would also need to carry that, too. Its mass-ratio would then be very much like that of a rocket, and a simple calculation shows that if equipped with rocket engines, it could attain nearly enough velocity for a transcontinental flight just by flying like an ICBM. So once again it is not clear whether the Oberg atmosphere would make travel by lunar aircraft all that much easier than travel by rocket.

Finally, Bob Farquhar of NASA-Goddard has done a great deal of very fine work on lunar libration-point communications satellites. These would provide much more reliable and efficient communication than any lunar ionosphere, for use by an extensive lunar community. Thus, they would be the lunar counterparts of our Earthside communications satellites, which of course have already replaced most forms of ionospheric communication over the Earth.

I note also that Oberg wonders whether it would still be possible to use a mass-driver in the presence of his atmosphere. The answer is very simple: No.

T.A. Heppenheimer
Heidelberg, Germany

Thinking of the food supply problems that have been discussed in the *L-5 News* recently, I might have a workable suggestion as far as meat goes, We are raising quail (sort of a hobby . . .). The breed we have (Coturnix: Pharoh D-1) lays one egg a day, reaches "laying age" in six weeks and full size in eight weeks. They are as prolific as bunnies-and tastier than chicken. I will keep record and weights, etc., and let you know how they size up as a food source.

I was also wondering what sources are under consideration on L-5 (for L-5?). Sometimes it would seem that a lot of food sources are being overlooked because they are non-western food sources. There are a lot of things that are edible (and highly palatable), that are often overlooked because they are unknown. Over 30% of the world's population delights in sweet manioc (casaba), a tuber that is grown in the tropical regions. I don't know what kind of potential it has as an L-5 crop, but I have the idea that most of the researchers haven't looked into it. (My opinionated opinion!) Has anyone looked into the possibility of raising fish? I know of one variety, Tilapia, that does not require moving water and lives on algae. I also understand that it breeds fairly well.

Shirley Ann Varughese
South Somerville,
New Jersey

(More letters on page 24)

Developing Space Policy

The international implications of space development by nations or corporate entities are extensive. Can a policy be designed for organization, law, and security in space?

Jack D. Salmon

(Prepared for presentation at the XVIII Annual Convention of the International Studies Association, March 16-20, 1977)

When one surveys the alternative technologies and strategies usually recommended for energy policy it becomes quite clear that the industrialized nations perceive the situation as indeed desperate. The most obviously desperate "solution" is that of aggressive war, hinted at in 1974 by American officials claiming that the enormous consumption of the industrialized societies somehow creates in them a "right" to continue their consumption pattern and therefore a corresponding "duty" of resource holders to supply the needed materials. This "duty" would of course be enforced by military means if needed. Given that even the Arabs have limited supplies of petroleum, and the possibilities of major war inherent in such actions, this is at best a short-term, politically expensive and exceedingly dangerous solution.

Slightly lower on the desperation scale come such proposals as that of bulldozing and boiling major portions of several American states in order to secure energy from oil shale, overlooking both the magnitude of environmental problems created and the probability that the herculean efforts required would consume nearly as much energy as they would produce. Massive coal mining may be nearly as costly, although more likely to produce useful output. Nuclear power has failed miserably of its early promises of cheap, clean and limitless power, and even its proponents speak of "Faustian bargains." Fusion power, once devoutly sought, seems increasingly to resemble fission power: it probably will produce radioactive waste products in significant quantity, and massive thermal pollution. It would also contribute to the continued rise of a politically powerful technocratic elite dominating centralized energy systems (see bibliography: Lovins).

Recognition of the great biological and social dangers of the "normal" solutions proposed has produced a whole school of "scarcity politics." Its members range from the relatively sanguine Schumacher and Lovins to the pessimistic Heilbroner or Ophuls, and the truly frightening visions of the Paddocks or Hardin (for all references, see bibliography). Their prescriptions frequently involve draconian population control and reduction programs, drastic reorientation of social and political values, and very different types of technology. It is true that, as Lovins claims, the actions needed to accomplish "alternative technology" solutions are no more drastic than those required to continue policies of "growth as usual" but the latter policies have the great advantage of falling within what Pirages and Ehrlich have called the "dominant social paradigm." Kuhn and others have amply illustrated our intellectual and social preferences for change by incremental processes; the scarcity school is proposing something far more sweeping.

Yet we face a tremendously important quandary: if the developed nations are to maintain the lifestyles to which they have become accustomed, and even more if there is to be any possibility at all for third, fourth, and fifth world nations to realize human dignity, we must not only maintain but enormously increase our energy production. Energy supplies are seen by industrial societies as necessary to maintain a rather plush lifestyle; to the majority of the world's nations, access to vast supplies of relatively inexpensive energy is essential if there is to be any possibility of escaping the developmental dungeon in which they now languish.

Social and political preference is then strong, even extreme, in favor of in increasing the availability of energy. But ecology teaches us that it is not possible to do only one thing: increased energy use will perturb the total environment, at possibly disasterous cost. At some point not too far in the future (at present rates of growth, perhaps little more than a century), continued energy use based on fossil and nuclear fuels will bring the planet up against the ultimate barrier: the ineluctable working of the Second Law of Thermodynamics and consequent planetary thermal balance changes, with possible consequences including extinction of the human species. There is a simple, basic fact: a finite planet cannot contain infinite growth. At some point, growth must stop; the only significant choices open to us are those of when and under what conditions growth will stop.

It is not then possible to solve the problems of the human condition on our planet by means of applying conventional, or even somewhat unconventional, technological solutions. Selected techniques such as geothermal, ocean thermal, wind and solar power can certainly help and should be pursued, but they cannot *solve* the world energy problem. If the developing nations are to continue population growth and aspire to improved material standards of living, most alternate energy sources can't even help very much. The demand will simply be too big, and environmental costs may wash out much of the nominal gains.

But technological optimism-the belief that humanity will somehow find a technological solution to virtually all problems, if it is really needed-possesses tremendous social inertia; it won't stop being part of our dominant social paradigm because of mathematical impossibility. And it's even possible, to the amazement and perhaps the dismay of at least some members of the scarcity school, that there is a feasible technological solution which has a relatively short lead time (perhaps twenty years), promises not only vast supplies of energy but other valuable side benefits such as less environmental damage, and has a high content of adventure and glamour.

The High Frontier

The possible solution is an outgrowth of the technology and science of the last decade; prior to about 1970 it would have been science fiction, or at best speculative science. Technology developed for the Apollo Moon voyages, coupled with geological findings on the Moon and recent spectroscopic analyses of some asteroids, provided the needed technological advances and data base. Professor G.K. O'Neill of Princeton in 1969-70 assigned his freshman physics seminar a problem: "Is a planetary surface the right place for an expanding technological civilization?" From the initial surprising findings flowed other questions and supporting results, leading to what is now a well-developed conceptual design for development of human civilizations in space. One of the major activities of these industrial societies would be construction of very large solar power stations to orbit the Earth and supply electricity to the planet by means of a microwave relay. This energy would be provided by our neighborhood fusion reactor, the Sun, in inexhaustible quantities for millions of years into the future, and would do so at minimal environmental and thermal cost to the planet. This additional energy would permit the developing nations to improve their status and the developed nations to maintain theirs. If the observed pattern of declining population growth in industrial societies holds, the population growth problem should eventually and "naturally" be reduced somewhat. There is even the possibility, if the concept proves out in all aspects, that a significant proportion of the human population could move completely off the planet, thus relieving the world of still more environmental and energy burdens.

This concept is a technological optimist solution to *all* the conventional scarcity problems. By importing energy to the Earth at very low material, environmental and thermal cost the "limits to growth" barriers are pushed back considerably. This buys time to accomplish other requirements if needed Further, the possibility of less stressful and more rapid industrialization of the developing countries, coupled with the possible longer-term migration of significant numbers of people to off-planet locations, may greatly aid in solving the problems of population growth and world social inequality. It is even arguably possible that peace would break out on Earth, since incentives to covet one's neighbor or one's neighbor's resources would seem to be less, while the adventures of the high frontier would absorb national energies. Should apocalyptic war happen, parts of the race might survive in space and begin again.

Problems on the High Frontier

There is now a growing literature of technical and economic analysis of the concept, most supporting its feasibility. R&D programs are underway in both government and private agencies, a citizen's lobby exists, international agencies (including the UN) are taking interest -- for a concept which first came to public notice only four years ago, a very respectable record. But there has been little attention paid to problems of international politics, political or organizational dynamics, and socio-political consequences in general. Technological solutions are useless if society cannot provide the support needed; if the costs are too high, that support neither will nor should be forthcoming (Ford Foundation, ch. 1; Loving).

> *"Space industrialization will probably be adopted, if at all, primarily because of the energy component of the system."*

Among the necessary elements of support for space industrialization are several factors directly related to international politics. This article will offer a preliminary examination of three such factors; international law, international organization, and national security policies.

National Security implications of Space Industrialization

One reason the U.S. is currently short of oil is that for many years a system of tariffs and import quotas kept importation of foreign oil to a minimum, encouraging consumption of oil produced from domestic wells. This policy, which someone has called "drain America first," was justified on the grounds that development of domestic energy sources would make the U.S. independent of foreign sources in time of war. "Project Independence" has been explicitly justified on the same grounds. Additional examples of national concern over the security of energy sources could easily be cited from Japan, France, the United Kingdom, and others. But as the American example shows, we need not assume that policies urged on the grounds of national security necessarily help that cause.

Space industrialization will probably be adopted, if at all, primarily because of the energy component of the system. For economic and social reasons, provision of abundant and low-cost energy energy is of very high priority; for national security reasons, obtaining the energy is a high priority but carries with it the requirement that vital energy sources be protected against destruction or capture. Analyses of the probability that American troops could capture, hold and produce Arab oil fields under hostile action suggested that the bet was rather poor; little more has been heard of the idea. Might solar power satellites (SPS) have similar status?

There are a number of components in the complete system, all essential to successful operation and growth: Earth-based launch and microwave reception installations; the mining and mass-launcher facilities on the Moon; the industrial colony; the SPS itself. All are vulnerable to sabotage, but this is true of any major installation and would presumably be dealt with by normal anti-sabotage methods. There is no obvious reason why sabotage would be more successful here than in any other power system.

Direct attack on the lunar facilities or the colonies would, if mounted from Earth, have a long lag-time due to the distances involved. ABM systems could probably be designed to work under the favorable conditions of vacuum and long warning times; the availability of vacuum and massive electrical power suggests the possibility of laser-based defenses, already under study for use in the more troublesome atmospheric environment. Direct attack on the Earth launch facilities or microwave reception system do not seem in principle any different from attacks on existing power plants and distribution centers: there is no known guaranteed defense in either case, only the general deterrent posture for the superpowers or the conventional defenses available to all nations.

The weakest point is the SPS itself. The SPS and its ground antenna are the only system elements which, if destroyed, would cause immediate loss of energy. Destruction of the other components -- industrial colony, Earth and lunar launch facilities -- would have only delayed effects. All SPS designs are large and relatively fragile targets, close to Earth (approximately 22,000 miles or less), and in fixed orbits. They appear to be relatively easy targets, and their destruction would have large and immediate effects on national defense and economic systems. This makes them high value targets of the type to which an enemy would devote enough of his striking force that defense would be very difficult, and successful defense unlikely.

But destruction of an SPS would be

a major, unambiguous act of war, and presumably would not occur unless core national interests had become involved. To the extent that deterrence works, SPSs should be protected; if deterrence fails, SPSs are simply another item on a long list of hard-to-defend targets. Major nuclear or fossil-fueled generating plants are also vulnerable, although more numerous and less significant as individual targets.

The best, and perhaps the only effective, defense for SPSs may be similar to the defense currently used by the U.S. and the U.S.S.R. for their cities and industries: a mutual vulnerability so naked that each side holds the other's cities as hostages for good behavior. Alternatively, to build upon the functionalist argument, an SPS system which is internationalized and produces power for several nations may thereby become a common good immune to rational destruction. I will return to this point later.

But national security policies must deal with many situations short of war: diplomatic pressure or economic rewards and punishments are normal parts of international relations. Use of "the oil weapon" by some members of OPEC has proven sufficient to alter the foreign policies, or affect particular actions, of a number of nations. It is this fact, more than fear of a cut-off in time of actual war, which gives great impetus to the attempts by a number of nations to reduce their dependence on foreign energy supplies.

An SPS system under national control would serve very well as a peacetime energy supplier, quite beyond the influence of any other nation. The Sun cannot be "turned off," there is no monopoly on space solar power by one or a few nations due to a peculiar concentration of the resource in a few areas; tankers cannot be harrassed or shipping lanes closed; the price cannot be affected by foreign action. Because its input is from a self-renewing source of (for practical purposes) infinite capacity, investment in this option is different from strategies based on exploitation of fossil resources, which would become increasingly expensive and increasingly limited over time. Because the system output is electricity, an energy form which could be used to synthesize other energy forms, such as hydrogen, the SPS system could be a fundamental building block in a varied and quite "independent" energy system.

Although there is clearly need for more detailed study, a first pass national security evaluation suggests that the space industrialization/SPS system has a very favorable potential. If it is possible to design an internationalized SPS in such a way that it cannot be an effective economic weapon and becomes less significant or attractive as a target, we can have the best of both worlds.

An international public policy favoring an internationalized SPS system requires creation of a suitable legal and organizational matrix.

A Legal Regime for Space

Over a period of several centuries there developed a net of national and international law to govern the activities of both states and private individuals on and in the sea. Because of the technological limitations which existed until quite recent times, the legal regime of the sea dealt with the margins of the ocean (territorial waters), a narrow layer at the top of the ocean within which fisheries were conducted, and with rules for navigation and passage on international waters. The sea floor and deep ocean activities in general were rarely important enough to be legally noticed. But recent technological developments, economic pressures, and national security concerns have combined to produce not only interest in but considerable conflict over a restructured and extended law of the sea. In particular, the political and economic demands of the poorer nations for a share of the oceans' wealth have been resisted by the wealthier nations who possess the technology necessary to exploit the ocean and gather its wealth.

> *"Space law is still a rather new field with few precedents, vested interests or entangling rules."*

Space law has a similar, if shorter, history (Lay and Taubenfeld, ch. 3). It has grown rapidly but incrementally, following technological feats which aroused a need for some legal integument, and has roots in several areas: arms control and national security, desire to advance international cooperation (Kash), economic needs, political rivalry, and even civil damage claims (who is responsible if a chunk of French satellite falls on Cousin Herman in Chicago?). It seems reasonable to assume that serious consideration of space colonization will arouse the same type of questions as have arisen since technology made it possible to exploit ocean resources more fully. The outcome of law of the sea negotiations may thus be quite significant for space law as well.

However, the differences between sea law and space law may be as significant as the similarities. In particular, space law is still a rather new field with few precedents, vested interests or entangling rules (Finch; Lay and Taubenfeld). Such principles and practices as do exist are quite broad and generally enabling as much as restricting. This adolescent state may benefit space colonization: if there can be described soon an appropriate, architectonic model to organize and guide development, decisions may be made and programs established in the near future, and with some confidence.

The complex and interdependent nature of large-scale space industrialization makes it desirable that our conceptual models deal with whole systems. A legal equivalent of the systems design method much used in NASA's engineering development may be appropriate, in which one attempts to construct an integrated model of all relevant systems and then optimize performance of the total system rather than maximize the performance of a particular part. This of course requires that social, political and economic factors be part of the analysis, integrated with technological designs. Although this would be one of the largest projects of social analysis ever proposed, it is not in principle impossible and is in fact a type of world order model (Falk; Mendlovitz). NASA has stressed the additional values produced by space program "spinoffs" into the civilian economy, such as biomedical devices, ceramics and systems engineering; a social science project of this magnitude might well prove quite valuable for its secondary social and methodological results as well as for its primary purpose. The study might show insuperable difficulties and avoid diversion of vast resources into a doomed program; if the results are promising, problem areas and solutions would have been illuminated and the project both improved and speeded (Bobrow).

The legal profession is probably the most advanced non-technological profession in space matters. Several international treaties, both bi- and multi-lateral, already cover a number of specific topics. National and international legal conferences meet frequently, the American Bar Association has a Committee on Aerospace Law, there is a legal subcommittee of the UN Committee on the Peaceful Uses of Outer Space, and legal panels have been prominent features in more technically-oriented conferences (e.g., the International Astronautical Federation).

Who owns resources in space? Who can own them? Under what conditions? How may they be used? How are economic costs and benefits to be apportioned? These questions must be dealt with in international public policy for space, as they are now being threshed out in maritime law.

Our chief current source of space law is the 1967 "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial

(Continued on page 13)

Arthur Kantrowitz proposes A Science Court

An idea that has been around for a while, and is now gaining widespread support, the science court is discussed in depth by Dr. Kantrowitz, its originator.

L-5 INTERVIEW by Eric Drexler

Dr. Arthur Kantrowitz, a member of the L-5 Society, is chairman of Avco Everett Research Laboratory and senior vice-president of Avco Corporation. His research work has included physical gas dynamics, magneto-hydrodynamics power, high power lasers, cardiac assist devices, strategic technology, and social control of technology.

Drexler: What purpose would a science court serve?

Kantrowitz: The science court is a procedure intended to produce a statement of the scientific facts when these facts are necessary for the making of public policy. To a great extent it has been discussed in terms of problems: the problems of our environment, the problems of nuclear power, and so on. However, I think that as far as people who are interested in large-scale space programs are concerned, it should be regarded as a procedure which might have some utility in assessing the facts about the benefits and the costs of, for example, a space industrialization program. It might help change a situation in which many people will reject these opportunities without having examined the technology in sufficient detail to find out "what is wrong with it." It is on the difficulty of starting anything new, posed by the tactic of ridicule (which has always been the tactic against anything really new and important), that it is hoped that the science court procedure could have an impact.

Could you give an example of this?

If, for example, one would ask any of the leading proponents of space industrialization to defend his claims against a tough cross-examiner, in the presence of scientific judges who are neutral toward the question, who are not biased against it or in favor of it, and if, for example, someone like Peter Glaser would claim that he could produce electrical energy from a solar satellite for so much a kilowatt-hour, he could be challenged to substantiate his claim in detail. The question would not be whether his claim sounds good, but where did this number come from, and where did that calculation come from, and what extrapolations are involved, and so on. I think that this would be a service to the space industrialization program.

How would the court operate?

I would say that the key rules in this system are that you deal with facts only, that we don't make any political or value judgments, or make any recommendations of that sort, that you separate advocates from judges, and that you do the whole thing in public. Those are the only rules that everybody seems to be agreed upon. The procedure was worked out by a task force of the presidential advisory groups and is reported in more detail in the August 20 issue of *Science* magazine.

A factual statement might be that a ten gigawatt satellite solar power station would cost a certain amount to set up. We won't say whether such things are a good idea or not. We won't get into the question of whether or not conserving energy is good for your soul, but only whether you can produce energy this way, or conceivably how much energy you could save by certain conservation measures.

The procedure would start after the case managers had been chosen on both sides. They would screen suggested judges for prejudice and, if both sides accepted them as unprejudiced, and if both sides accepted the details of the procedure, then it could go forward. We would try to see if they could be mediated to get agreement on statements of fact, but if not then each side would be asked to substantiate their claims in detail and would be cross-examined. If finally no agreement could be made, then the judges would write a statement of what they thought the facts were on that particular question.

How are equivalent decisions made today? What would the science court replace?

Well, there certainly is a process today. How it goes, in dealing with complicated technical issues, is quite variable. For example, one way is by a referendum such as recently was held in California on nuclear energy, in which the public votes on whether nuclear power shall go forward. I think mostly it votes from confusion. Few people today have spent the enormous amount of time that is necessary to understand the technology of nuclear power. Nevertheless, everybody votes about it, despite an enormous uncertainty about what the facts are. That way has the advantage that the whole thing is done in the open. Frequently it is *not* done in the open. Decisions about technical matters are frequently made by political figures who sometimes use the confusion about the facts to make their lives more comfortable, to conceal value judgments that they'd rather not discuss in the open, and to avoid the uncomfortable need to exercise real leadership. If, for example, our new president would undertake to lead the country into an adventurous space program, I think he would go down in history as a very great leader. However, if you consider what he would have to undertake to do this, you realize that it would be almost impossible. To convert a scientific and engineering community that has become used to extreme conservatism back to an adventurous policy would be almost impossible for him. However, if, for example, the satellite solar power station had gone through such a procedure and the facts that were delivered by a credible procedure were that this is a practical, cost effective, environmentally acceptable way of getting all the power we might need, then indeed it would make life much easier for a political leader who wanted to be courageous to make the decision, "let's go this adventurous way."

The science court has been rather controversial. What have some of the objections been?

The objections that have been raised to the science court divide into several classes. First, there are those who say that you can't do it because you cannot separate facts from values or political or moral judgments, that wherever there is any uncertainty people will inevitably be biased in their judgment of the technical uncertainty by the way they want the answer to come out. I would respond to that class of criticism by saying that the separation of facts from values is fundamental to all science, that you can only do science on those observations of nature on which all people can agree. People will not agree so generally on value considerations. I think that one of the things that has gone wrong that leads to the pessimism and conservatism that we have today is the intrusion of value-laden arguments into what are purportedly factual discussions. How I would respond to people who say that YOU can't do it is that it is high time that we tried as best we can to separate out the factual questions, to deal with them as best we can, and to perfect our methods of eliminating prejudice. I think that if you set out consciously to separate facts from values you will do better than is done today, when no attempt is made to make that separation, when it is not considered unethical to introduce your politics in distorting the facts as submitted to the public.

The moral scientist will lie?

The moral scientist will lie, or one could put it as the students at the University of Moscow do. They have the standard description of philosophy that students have developed the world over, that it is like searching for a black cat in a dark room. They also take courses in Marxist philosophy, which they identify as searching for a black cat that isn't there in a dark room. Then they take courses in Marxist-Leninist philosophy, which they have identified as searching for a black cat that isn't there in a dark room and periodically announcing, "I've got it!" That epitomizes to my mind better than anything I know the role of the ideologue in the distortion of facts. The invasion of what purports to be science fact as purveyed by one list of Nobel Prize winners or by another list of Nobel Prize winners opposing them is just the distortion that the students of Moscow University were complaining of. It is the ideologue driven by the pressure of his ideology to find the black cat.

Regarding the objection that you can't find unbiased judges (and that might have some truth in it) I think that if you submit the judges to a screening process, where both sides will accept them as unprejudiced, you'll be better off than when you don't have such a procedure. That is a procedure copied from the law. While nobody could argue that there will be no traces of bias present, it might be an improvement over what we've got, where there are no such protections,

A third criticism is summarized by asking "Who guards the guardians?" The best answer I can make is that this procedure should always be done in public. In fact, it should be done more than in public, one should make an aggressive effort to interest the public in these scientific questions, which are really basic to their understanding of what their future is going to be like, through an effort to capitalize as best as one can on the drama that is inherent in a confrontation between two people where one is stating a fact whose validity is very important to him, he's built his life around it, and another man has his career based on exhibiting how well he can take apart this statement. One can have some confidence that after a procedure like that is over, and after all the blood has been wiped up, that indeed people have been motivated to get all the facts out. I think that the questions that would be dealt with are so important to the future that we should have a procedure that will achieve the credibility that it gets by public exposure. Of course it is true that if such a procedure goes on day after day after day, the public will lose interest in the whole thing to some extent unless it is very cleverly staged, which I don't think it will be. Nevertheless, it should attract more interest than such procedures do now when they are closed to the public completely.

A frequent objection has been that the science court will declare that the Earth is flat. The possibility that a procedure of this sort might reproduce some of the features of medieval and renaissance church courts is really based on a misapprehension. Those courts attempted to impose upon science the values of the medieval church. They had no concern with the separation of scientific fact from religious dogmas, so they were quite a different thing.

A very wise woman who has thought a

(Continued on page 16)

Boeing designers answer questions about Satellite Solar Power

Gordon Woodcock and Ralph Nansen, two men in the forefront of SPS design, tell why satellite solar power is the way to go, and give tentative answers to some environmental questions.

Interview by Norie Huddle, with Carolyn Henson

Ralph Nansen is the Satellite Solar Power program manager for Boeing Aerospace Company in Seattle, and Gordon Woodcock is the SSPS study manager. They were interviewed by Carolyn and Norie at the American Institute of Aeronautics and Astronautics annual meeting in Washington, D.C.

Carolyn: A lot of people question why it is necessary to put solar power stations out in space when you can collect solar energy here on Earth. Could you comment on this? Why would you want to have these in addition to, say, the central towers here on Earth, which I understand that Boeing is working on.

Woodcock: A lot of people are working on the central tower concept, including Boeing. It's a little closer in technology, of course. There are really two main reasons for going into space. The first has to do with the basic difficulty in the utilization of solar energy: you have to spread out over such a large area to collect the amount you need. In space you need about one-sixth of the area that you do on the ground, in terms of the actual collectors. First, because the sunlight is more intense because there is no atmosphere; second, the shadow periods, although they do exist, are very brief and represent less than one percent outage factor; third, more subtle but very important, is that we can point our collectors at the Sun, whereas on the Earth you have to live with whatever direction the ground happens to be pointing. The Sun goes across the sky and you have to track it with all these mirrors.

Carolyn: So tracking presents a serious problem with Earth solar power?

Woodcock: It does, but certainly a solvable problem. It has been solved.

Carolyn: But it costs a lot.

Woodcock: It costs some the second reason for going into space, again related to the large areas required by collectors, is that the design loads are so close to zero that we're having a little trouble defining just what they are. It's almost certain to be true that the actual design loads on one of these structures will be imposed by the assembly process rather than by the operational process.

Carolyn: You don't have to worry about windstorms or birds sitting on collectors or things like that?

Woodcock: If all we had to worry about was the satellite itself, that advantage would be enormous. But we do have to have a ground receiving station, and, interestingly, by the estimates we have worked out so far (we haven't worked on the ground receiving station very hard), ninety-five percent of our total system mass is in the ground and only five percent is satellite. That's because the ground receiving station does have to withstand gravity and wind loads.

Carolyn: What is the ratio of the area taken up by a ground receiving station versus an equivalent-sized solar power station on Earth?

Woodcock: The rough cuts we've taken of that are ten to one in favor of space-based power. It turns out, interestingly enough, that the total area of the ground receiving station is quite comparable to the total area of a satellite. There is no fundamental reason why this is true, it is more of a coincidence than anything else.

Now, the reason that I say ten to one Instead of six to one is that because of the situation of having to track the Sun across the sky, with a ground solar power plant, something less, I believe, than fifty percent of the land covered actually is collector; the rest is space between collectors. So there is a big difference.

Really, you're putting this in the context of an "either-or" situation, and that's not exactly right. To begin with, ground solar power is closer in technology and, second, it lends itself naturally to intermediate load service. The space system lends itself naturally to base load service and would be considerably less well suited to intermediate load. The two tend, therefore, to be complementary.

Carolyn: Shifting here, what kinds of power costs can people expect from solar space power, what kinds of environmental advantages, and what kind of time frame can we expect to see this happening in, if work proceeded in a reasonable fashion with no delays in funding or anything?

Woodcock: Well, starting from the top, the concept involves the placing of large power stations in a geostationary orbit, which collect solar power and convert it to electricity, beam it to Earth on radio waves, reconvert it to electricity for commercial use on the ground. Each station would be able to produce on the order of 10,000 megawatts of useful power. That is, for example, enough to run New York City. So, a reasonable number of satellites-say, fifty to one hundred, would be enough to run the whole country, if that were necessary. The benefits of the satellite system have to do with its relatively benign environmental impact, which is true of most solar energy schemes. Its ability to run day or night and not be bothered by weather or sunlight, its relatively small consumption of resources to construct the station because of the advantages of construction and collection of solar energy in space, and finally, because there doesn't seem to be any kind of capacity limit that we can find. That is, however much energy you need, you can get it from this source. The only limit we know of is that if energy utilization by man grows indefinitely, eventually you reach a point where you've got a thermal burden problem on the Earth. What I mean is the Earth receives a certain amount of energy from the Sun in a natural manner. In our utilization of all energy sources (except ocean thermal difference and ground solar power), we release additional heat into the environment. If you project the current growth rates for the use of energy for about 150 years, you get to the point where the artificial induction of energy into the Earth's environment -- power consumption -- becomes about one percent of the natural energy source. Somewhere along there you begin to expect some difficulty with climate change. (The Sun's input of energy to the Earth varies a few percent from time to time anyway.) Now, it's probably unlikely that the energy consumption on the surface of the Earth will grow that much for reasons of population limits and other factors. And, interestingly, the satellite form of power, although it does impose a thermal burden because the electric power that is utilized eventually turns to heat after you have used it, has very little waste thermal heat-it is dumped in space, not on the Earth.

As to the costs involved, I don't think we're in a position to make firm quotes. We've made a number of estimates and the range we've published in terms of the cost of electricity in 1975 dollars ranges from about 25 mills per kilowatt hour to about 75, and that's a rough representation of the uncertainty that we presently see. (These are bus bar costs. You'd have to add about 10 or possibly 15 mills to that to get retail costs.) That just about compares with the range of retail costs today. You find that the hydro projects in the Pacific Northwest and other locations, where the capital costs of the facilities have already been written off, run for operating costs of 3 to 4 mills. There the retail rates are around 15. . . I think I pay around 18. Some people in Seattle pay a little less than 15. The other extreme, in the continental U.S., tends to be in the New York City area, where people pay 80 to 90. Now these satellites would behave in one respect like hydro power, because we use the typical accounting scheme of depreciating them over thirty years; there is no reason to think they'd be shut off at the end of thirty years. And after that time, they'd look like hydropower, with an operating cost in the 3 to 5 mill range.

You asked about time. That's a very interesting question. If you take the largest known oil reserves in the world, Saudi Arabia's, and you divide their known reserves by their current production rate, they're going to last forty years at the current production rates. Presumably, most of the other sources will be gone by then. Now nobody knows for sure how much there is yet to be found and there are a bunch of elegant theories with bell-shaped curves and all that sort of thing. By the end of the century, oil will be in short supply, and by the middle of the next century, it will probably, for all practical purposes, be gone, except for feedstocks for certain plastic industries and so forth. The range of scenarios we've looked at for constructing a system of this nature range from: (1) having a full go ahead for the whole system, which would take around twelve to fifteen years. There isn't any indication that there will be any such "go" signal in the near future. (2) A development that goes through some sort of pilot development phase, which most new energy sources do, looks more in the twenty to twenty-five year range. But there aren't any technological barriers preventing us from starting any such program. We don't have to invent a means of doing this or that.

"We're talking about scaling up space operations by something on the order of thousands. And there is no reason why that can't be done. . . "

Norie: What do you see as the major obstacles for getting this program underway?

Woodcock: I can see two. One is the credibility gap. We're talking about scaling up space operations by something on the order of thousands. And there is no reason why that can't be done, but it certainly causes people to be concerned about the feasibility. The truth of the matter is that our space operations today are on a very, very small scale. The annual NASA budget, for example, is just about equal to the annual profit of the world's largest oil company. That is an interesting statistic that most people don't know.

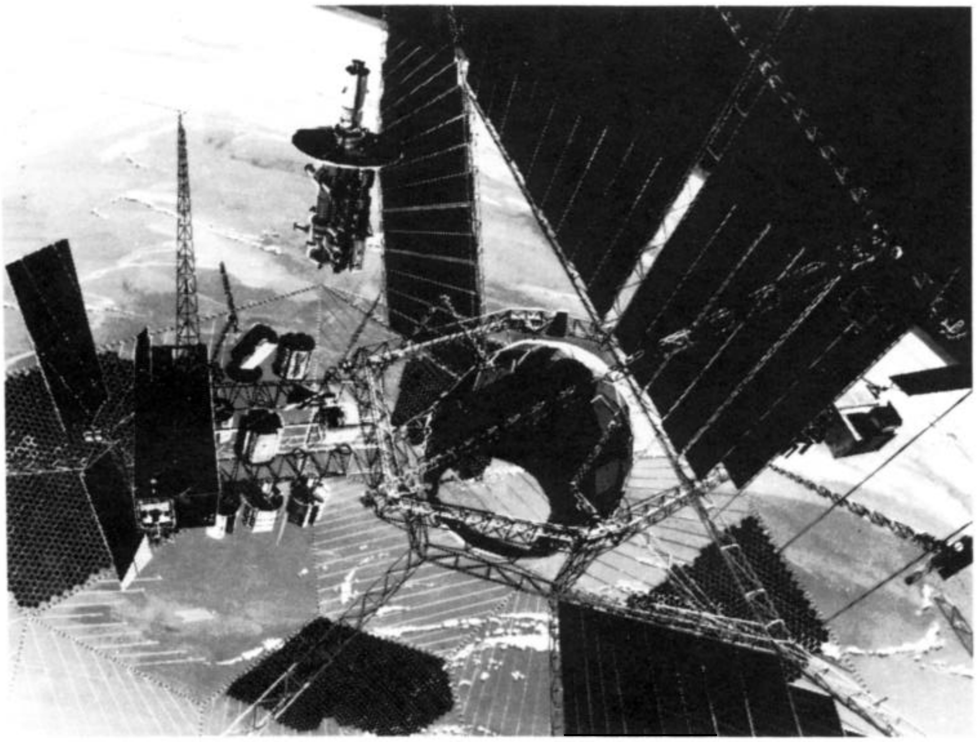
The second problem has to do with the fact that the development cost to bring in this type of solar power is probably higher than for the other kinds to which people have been exposed. Part of this is because we have to virtually create a new industry of space industrialization. The development cost is not high in comparison with the benefits; in fact, when you envision a whole program of this nature, then the cost of electric power derived from this kind of source-assuming you expand it to a useful size, lots of satellites getting lots of power-becomes quite low. If you try to recover all your development costs it raises the cost by a few percent. I would guess, however, that the total investment in this kind of a system would not be larger than it has been for other kinds of high technology new energy. I haven't seen any figures for the total development costs of fusion energy, but I would guess they are comparable. From what I know of the development of nuclear energy as a practical commercial source of energy, I would guess they are comparable. It's very difficult to get a good handle on the nuclear developments because there was a lot spent for weapons and it's hard to determine what the technology transfer is.

Carolyn: I wonder if you could comment on the traffic requirements for ground launched satellites.

Woodcock: One of the things that concerns people about this concept is the fact that the transportation system we've found to be economically practical for this purpose involves the use of a fully reusable rocket system, not ninety percent reusable, like the Shuttle, but completely reusable; about twice the size of the Saturn 5 Moon rocket, operated up to as many as ten launches a day. Now this is a somewhat startling requirement to most people; in the Saturn program we launched at most four vehicles a year. Even the Shuttle will probably fly about every two weeks once it gets into the operational phase. So ten launches a day is kind of mind-boggling to people used to the space business. The vehicle we're talking about is fifteen million pounds fully fueled, so ten liftoffs a day is about 150 million pounds a day, and that's a pretty big number. But if you take any of the large commercial airports and look at the vehicles they launch -- commercial aircraft which weigh on the average about 350,000 pounds -- they typically launch (if you can use that term) about 500 flights a day, and the total there is about 15 million pounds a day. So it's not at all outside our operational experience for flight systems; we just don't launch space vehicles at that rate. But there is no reason why we couldn't. In fact, the fleet size requirements for doing those ten launches a day, because of the potential of fast turn-around, is on the order of a few dozen vehicles.

Norie: What position are you at now? Where do you go from here in terms of research?

Woodcock: The program is. you can't even call it a program. Studies have been funded by NASA over the past two or three years. And there were some studies before that -- I think the first started in 1971 or 1972. A typical level of effort would employ six to fifteen people, depending on the size of the study and how long it was conducted. These studies and some key technology demonstrations, particularly in the area of microwave power transmission have convinced quite a number of people at NASA that the thing is technically feasible. The economic factor is still a



Boeing's SPS Construction Base Concept

little too uncertain to determine if it is economically feasible or not. At any rate, this year the study that we are conducting is at slightly under the million dollar level. There is another study that will be of a comparable level, issued from a different NASA center. They'll probably have that one underway in March or April so the level of study and the level of technology activity has gone up. The responsibility of the program may be transferred from NASA to ERDA and, in fact, some of the funding was money from ERDA that came through NASA. Now I might point out that the study was contracted in two phases: the first phase is under contract and the second phase is on option. So the government has not contracted at the present time to spend the whole $975,000, although we expect that they will. The planning that has been discussed for after the current phase of study involves approximately another year of study, part of which would be government in-house-looking over what the contractors do and making their own assessment. At that point, NASA is talking about what they call a "technology-advancement decision," not a decision to do the program, but a decision to fund the development and demonstration of the key elements, particularly in the areas of space construction, energy conversion and power transmission.

The position we expect to find ourselves in at the end of the current study is that it is technically feasible and that it is or is not economically feasible. In the latter case, I suppose we would quit. But the trend of our figures now is in the direction of improvement in economical feasibility, rather than the reverse. So I think we'll probably find ourselves in the position of saying yes, we think it is technically and economically feasible but here are some issues that need to be answered by tests before we can be sure.

Carolyn: What in the work that Boeing is doing is different from the Glaser work?

Woodcock: In terms of the concept, not very much. The concept we're dealing with is basically the Glaser concept. If you read his patent, you find that what he is actually patented is a satellite that would convert sunlight to solar energy by "some means," (not necessarily solar cells) and then transmit it to Earth by microwave power beam. That's basically the concept we're studying. We're trying to find out which of the energy conversion means is the best way to go, where is the best place to construct the thing, and to improve our estimates of mass and cost. I think probably the main contribution we've made is to bring a systems approach to bear on the problem, starting from an economic analysis. There are potential ways of getting the costs in the ball park, particularly space transportation cost. I think until we started working, no one really thought they had an answer to that one.

When you talk about several launches a day of a big, fully reusable vehicle, the costs really can be very low. The fundamental floor under the cost of the transportation is the price of the fuel, just as it is under the flying of an airline or driving an automobile or whatever. Using hydrogen costs appropriate to electrolysis, we find that the cost of putting a pound of payload in low Earth orbit in terms of the cost of buying fuel, is about three dollars.

Carolyn: How does that compare with air freight costs?

Woodcock: Depends on what you're sending and how far. It's a bit higher than domestic air freight but if you're shipping from here to Europe, then I think it's fairly comparable. Now the total cost of flying this vehicle by our current estimates is about five times that because we have to amortize our vehicle, have to operate it, do a little bit of maintenance on it after every flight, and there are a bunch of factors which bring the total cost to three to five times the fuel cost range. We think those estimates may be a little conservative, but we're still talking about dollars per pound that are a tenth or less of that projected for the Shuttle. And so, although possibly conservative, the numbers are a little bit surprising to people who are used to thinking of space transportation costing in the neighborhood of a thousand dollars per pound.

Norie: Have you done any work with environmental impact, or do you consider that premature?

Woodcock: Environmental impact is never premature.

Norie: Good, I'm glad to hear you say that!

Woodcock: We can't find any. I talked a little in my paper today about the land-use situation, but that doesn't seem to be very much of a problem because the land use is comparatively benign. People constructing things on the ground have a tendency to scrape the surface off with a bulldozer first, but that's not necessary in this case.

Norie: How about in terms of effects on the atmosphere?

Woodcock: The atmosphere emissions by the space transportation system would be small by comparison with those currently experienced with the commercial air fleet. We're burning a less polluting fuel, mostly hydrogen. Now we do distribute some of the emissions into the stratosphere which the present commercial air fleet doesn't do, but the principle known causes of stratosphere problems are NO, and fluorocarbons which we don't have. A rocket engine doesn't create NO, because there isn't any nitrogen in the combustion process. In the lower atmosphere, it is believed that it may create some by external combustion; that is, you see that rocket taking off with a great tail of fire. It is the result of the fact that the fuel to oxidize the mixture in the rocket engine is optimized for maximum performance, and there's a little excess fuel. The indications are that by the time you get into the stratosphere, you probably aren't creating any NO, because the secondary combustion appears to go out and the plume is very low pressure and very cool . . . and the things that maximize NO, formation are high pressure and moderately high temperature. From what I know of the process, it doesn't look as if there will be a significant NO, problem.

The other problem is the microwave situation. Microwaves are far less hazardous than ionizing radiations, like x-ray machines, or whatever. But there are some effects and some problems. We presently recognize in this country an exposure standard of ten milliwatts per square centimeter, but if you've read the microwave stuff, then you know the Soviets use a standard that is one-thousandth of that. And there is a great deal of controversy in the technical literature over what the standards ought to be and over what the effects are and that sort of thing. The nature of our SPS system is that we believe we could live with the Soviet standard with very minor cost/effect on the system if that were necessary.

There's one thing I like to bring out early on the microwave thing. I think it is probably a very important effect and I think practically everyone looking into this area has missed the significance-at least if they've considered it, they don't write about it. This has to do with the nature of the microwave beam itself. Microwave power comes in two principle forms. There is a continuous wave form, as in the microwave oven or an industrial heating application where you just turn the power on and it's on continuously. The other form is radar, which is pulsed. The exposure or flux limits that are discussed are always the average power level and not the peak. One can illustrate very simply the thing I'm getting at here by imagining that I've got a little box here on the table that's got a little mechanism of some kind inside, and there's an electrical terminal on top and I tell you the average voltage applied to that terminal is six volts. Most people realize six volts is not sufficient for you to feel it. Common lantern batteries are six volts. But if you were to touch that terminal, you would get a hell of a shock, because what I didn't tell you is that the voltage is applied at 6000 volts at one millisecond pulses, once a second.

Norie: Minor details.

Woodcock: Well, in a way, that's the comparison between pulse microwave energy and continuous microwave energy. I think that when we go about setting standards we should make a clear distinction between the kinds of forms that the microwave power can take. As best we can tell, the SPS could live with microwave standards that were stringent enough to cause most other industries a lot of trouble, for example, the television industry. Now there are some uncertainties associated with the propagation of the microwave beam through the ionosphere and through the atmosphere and I know of no way to resolve those completely without doing tests.

Norie: What kinds of problems do you think might arise?

Woodcock: The only kind of problem in the atmosphere is a little bit of scattering from the weather. There's not enough scattering to be a biologic effect but there could be a radio frequency interference with other RF spectrum users and that can be predicted. The guys who are looking at that carefully say that the problem is workable. The other one is the ionosphere and radio waves passing through the ionosphere will heat it a little bit-well, actually, quite a lot. There have been a number of experiments conducted where the ionosphere was intentionally heated by radiowaves. They picked a frequency at which the heating effects were fairly strong and, yes, you can do all kinds of things. You can change the electron density and so forth. I can't find any reason to believe that environmental alteration of the ionosphere has an impact in the ordinary sense. Heating experiments have been conducted down to 5 to 10 megahertz, and can get pretty strong reactions. The effect decreases with the square of the frequency. The frequency we have in mind (for our system) -- the 2450 megahertz frequency -- doesn't interact with the ionosphere very much; it's about 200 times higher than the frequencies that do react strongly.

So even though we're talking about relatively intense beams by Earth standards, by the standards of those heating experiments, we're expecting very little interaction. But if there were more than we expect, or an interaction of a different nature than we expect, the result on the beam could be to scatter it or something like that and make it more difficult to control. There are only two ways of exploring that problem. One way is to conduct some heating tests in the ionosphere at the SPS frequencies, using a large radio astronomy dish like the one at Arecibo, Puerto Rico. The other is to build a full-size SPS and find out what will happen.

Norie: What do you think will happen?

Woodcock: Well, initial Arecibo tests are going on now. The ionosphere physicists keep talking about these experiments at frequencies other than the one we want to use, but I think some of theseexperiments must be conducted at the SPS frequency. There is a second band we could use at 5.8 gigahertz, but it would be a little harder to engineer it. It would have still less ionosphere interaction, but more with weather.

Carolyn: On that higher frequency, what would be the effect of the amount of sunlight intercepted by the rectenna? Wouldn't you have to have the elements closer together?

Woodcock: I'm not sure how much difference it would make. Yes, you would have to have smaller antennae and more of them. There are a whole bunch of effects we haven't explored. The possibility of using this other frequency only came up a week or so ago.

Norie: Have you done anything in conjunction with other aerospace groups? Or with other countries like the Soviet Union or Japan in terms of trying to coordinate some of your research findings and discuss various possibilities of where to go from here in research?

Woodcock: The basic development is taking place primarily in the United States. There is some activity in Germany. The only association has been some interactions at symposia and papers given, with no interaction at all that I know of with the Soviet Union. The primary interface that various companies have in the United States is through NASA. Our contractor reports are attended by other contractors and we have some subcontract association with General Electric and Hughes for some studies and we have had others like Garrett and other selected companies. The primary work is similar to the way we do studies in other areas. But right now there is no activity outside of the U.S. as far as cooperative ventures.

Norie: Do you think this is likely to change?

Woodcock: Very likely, because if we're successful in evolving this total concept it becomes such a big industrial base that it is very doubtful that such involvement would not occur. In the aerospace and related technical fields, people share technology results pretty freely and, further, if the work is contracted by the government as most of this work is, then the reports (unless classified) are mostly in the public domain once they've been provided to the government. This is true since the Freedom of Information Act. NASA practices a very open and free policy of distributing these reports to all of the industry people interested and just about anyone that is interested in them can get them unless they have run out of copies.

Norie: Do you have any suggestions how a group like the L-5 Society can be constructive or effective in this whole development?

Woodcock: I think that although I have some technical disagreements with L-5's proposals for the way to go about this program, they reach effectively a segment of society that we do not-and that is the university people.

Norie: I take it you have had talks in the past on the technological aspects you disagree on?

Woodcock: Oh, yes! (Much laughter from him and Carolyn.)

Carolyn: Actually, I won't take a stand on that, but we do definitely stress

(Continued on page 17)

esa nasa

spacelab

Hitching a ride into space on the Shuttle, Spacelab will carry palletized experiments exposed to conditions in space. Here's what happens.

In preparation for the Shuttle era, the European Space Agency is developing Spacelab. Spacelab consists of two basic elements-a pressurized module and an unpressurized pallet (or pallet segment) which can be used separately or in combination. In the Second Spacelab Mission, experiments should be planned for a Spacelab configuration consisting of three, four, or five pallet segments. The pressurized module will not be used. The pallet is an unpressurized platform to which instruments such as telescopes and antennas that require direct exposure to space may be mounted. The pallet provides basic services to the instruments, such as power, data distribution and thermal control.

Spacelab is carried to and from orbit by the Space Shuttle. It remains attached to the Orbiter throughout the flight and is controlled from the Orbiter aft flight deck. Figure 1 shows a typical pallet configuration of Spacelab in the Orbiter during its orbital stay.

Major external features of the Spacelab pallet configuration are shown in Figure 1, also. It consists of pallet segments which may be arranged in various ways. A pallet segment is approximately 2.9 meters long, 4 meters wide, and may be independently suspended in the Orbiter payload bay or it may be structurally connected to another pallet segment to form a pallet train. Either the individual pallet segments or the pallet train are attached to the Orbiter with a set of attachment fittings.

A subsystem igloo is mounted to the forward pallet and provides a pressurized volume to accommodate Spacelab subsystems normally mounted in the module. An instrument pointing subsystem (IPS), mounted on the pallet, provides precision pointing for payloads which require greater pointing accuracy and stability than is provided by the Orbiter. Verification flight instrumentation is carried on the Second Spacelab Mission to measure subsystem performance and environments.

The U-shaped pallet segments are covered with floor and side panels with inserts for mounting of light payload equipment. A series of hard points attached to the main structure of a pallet segment is provided for mounting of heavy payload equipment. The pallet, subsystem igloo, aft flight deck equipment, and IPS, are interconnected with power, signal and other utility lines for subsystem and payload equipment. Utility bridges support the subsystem and payload utility lines.

Figure 1 shows Spacelab in an exploded view. The subsystem igloo mounts to the forward pallet. The IPS can be located in any position on the pallet train. Controls and displays are located in the Orbiter aft flight deck at the payload specialists station. In the Second Spacelab Mission, the work station for the payload specialists is the aft flight deck. A maximum of two payload specialists can work simultaneously at the aft flight deck. Optional locations are provided for experiment electronics-pressurized equipment can be located at the aft flight

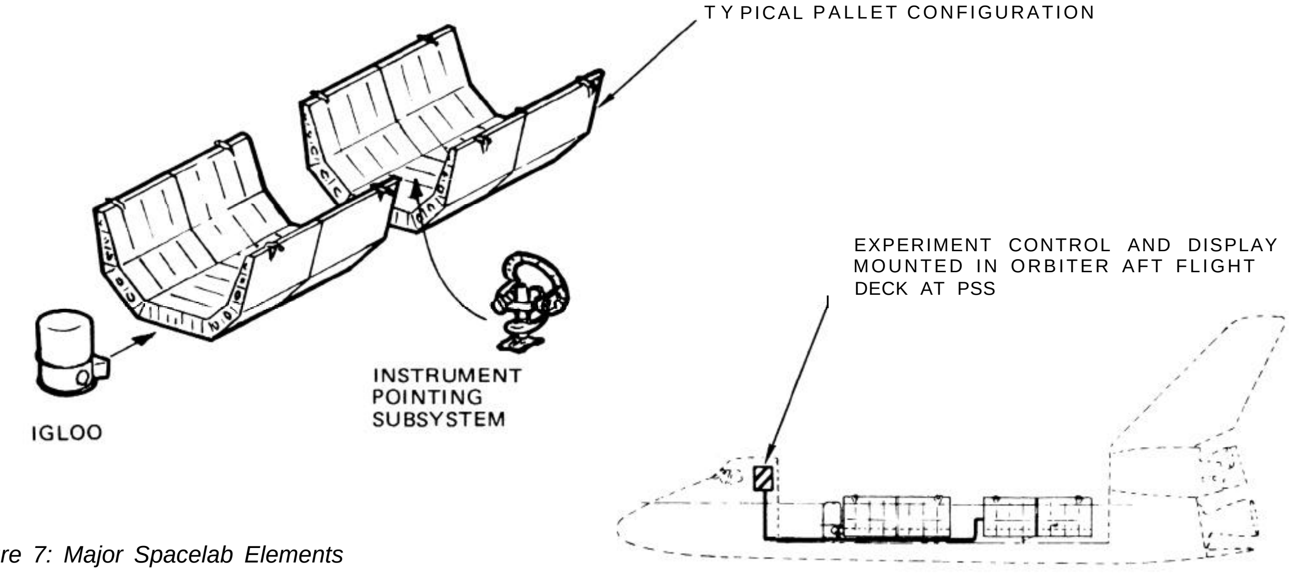

TYPICAL PALLET CONFIGURATION
EXPERIMENT CONTROL AND DISPLAY MOUNTED IN ORBITER AFT FLIGHT DECK AT PSS
INSTRUMENT POINTING SUBSYSTEM
IGLOO

Figure 7: Major Spacelab Elements

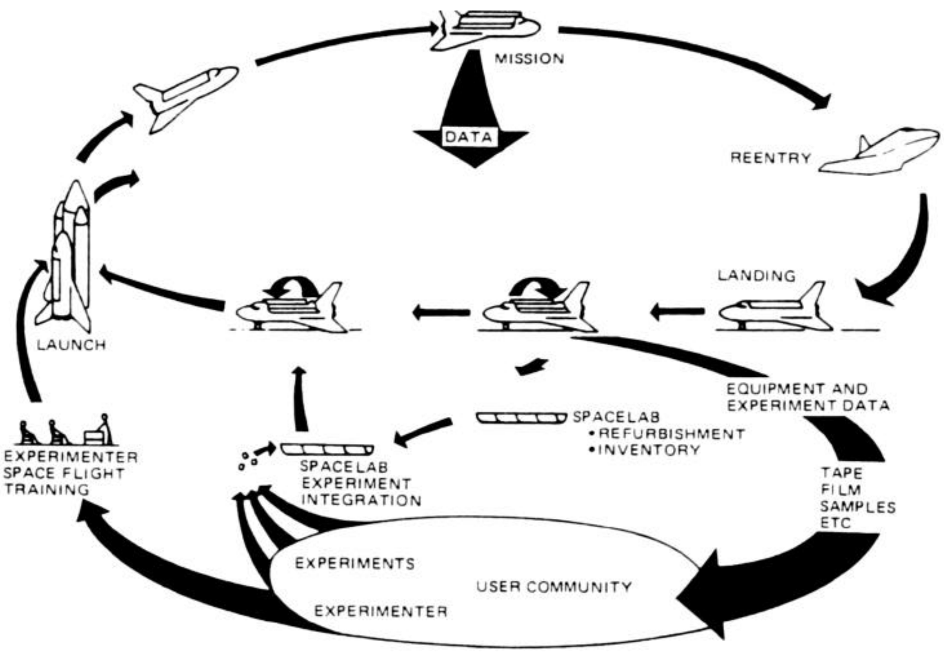


Figure 2: Shuttle-Spacelab Operational Profile

deck if crew access is required. Unpressurized equipment can be exposed to the space environment existing on the pallet or IPS.

In operational use, the experiment will normally be integrated on the pallet and on the IPS and checked out as a complete assembly. Interface connections with payload equipment mounted in the payload specialists station and with bay-mounted equipment will be verified after equipment installation in the Orbiter.

Spacelab includes many services for the users provided by autonomous and Orbiter-dependent subsystems. Modular design of subsystems allows a choice of part of the subsystem equipment by the users so that support for each mission is optimized.

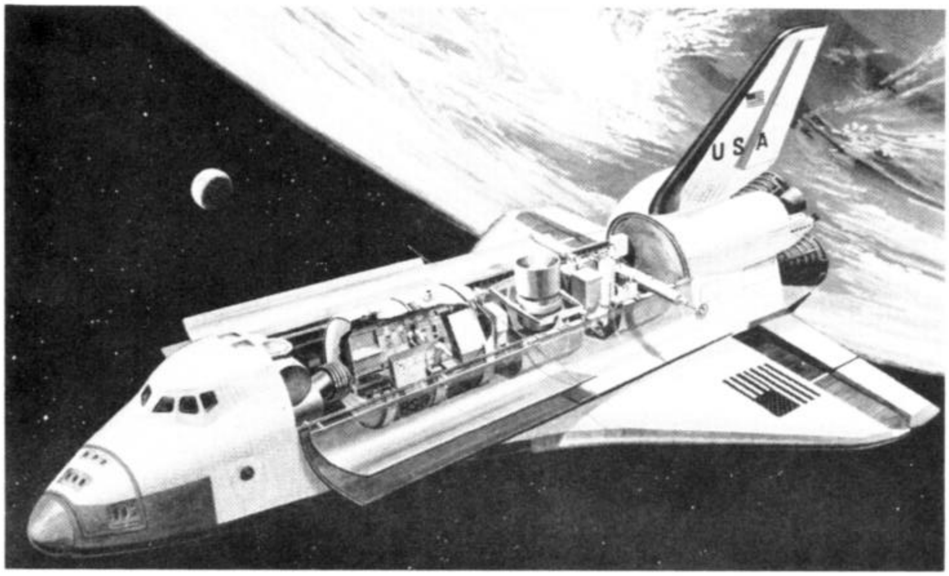
The Spacelab environmental control subsystem (ECS) comprises elements for thermal control of pallet mounted experiment equipment. Oxygen/nitrogen atmosphere at sea level pressure and other crew habitability support such as food, drink, sleep, hygiene, and waste management facilities are provided by the Orbiter.

The electrical power distribution subsystem (EPDS) distributes the basic electric power derived from the Orbiter's fuel cells to Spacelab subsystems and Spacelab payloads.

The command and data management subsystem (CDMS) provides numerous support functions, including data acquisition, formatting, display and recording. Onboard checkout and caution/warning are provided for both subsystems and Spacelab payloads. The CDMS provides three identical computers: one dedicated to data processing of Spacelab payloads, one dedicated to subsystem data processing and one backup computer. The CDMS subsystem is largely independent from the Orbiter subsystems, but is controlled from the payload specialists station located on the Orbiter aft flight deck. Communications with ground facilities, either directly to a Spaceflight Tracking and Data Network (STDN) station or via the Tracking and Data Relay Satellite (TDRS) system, is provided through the Orbiter communication system.

Figure 2 shows typical Spacelab operation cycles. Users' equipment is integrated into Spacelab, which is subsequently installed in the Orbiter. In the launch configuration, the Space Shuttle System consists of the Orbiter, a large external tank which provides propellant to the Orbiter during launch and two solid rocket boosters. This configuration is launched and propelled by the solid rocket boosters and Orbiter main engines.

The solid rocket booster and the external tank are jettisoned before reaching orbital velocity, with orbital velocity being achieved by the orbital maneuvering system. When the desired orbit has been achieved, the Orbiter and Spacelab will be activated and the doors of the Orbiter cargo bay will be opened to expose Spacelab to space for the duration of the on-orbit mission. Before reentry and landing, the Spacelab systems will be deactivated and the doors of the Orbiter cargo bay will be closed. After landing, Spacelab and the Orbiter will be refurbished as required and prepared for the next flight in separate ground operations cycles.



Artist's concept of the Spacelab being carried by the Shuttle. Both the pressurized module with payload specialists and the pallet segments are in place.

L-5 in Congress-Part 2

Dr. Brian O'Leary, in his testimony before the U.S. Senate, proposes that the legislators take a serious look at plans for space industrialization. Part 1, testimony by Dr. T. Stephen Cheston, appeared in the April issue.

Dr. Brian O'Leary, as our readers should remember, is holding the fort at Princeton while Dr. O'Neill is at MIT The folio wing testimony was presented before the Science and Space Subcommittee, Committee on Commerce, Science and Transportation, United States Senate. It was presented by Dean T. Stephen Cheston of Georgetown University on March 17, 1977:

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to express my views on the nation's space program. The opinions and recommendations I will present are attributable, in part, to experience derived from diverse roles I have played with respect to space exploration over the past 16 years -- as a space scientist, astronaut, critic, experimenter on a planetary mission, congressional energy consultant, and, most recently, as a participant in the development of an exciting new concept.

About six years ago, when NASA started development on the Space Shuttle program, I opposed spending $5 to $10 billion on this new space transportation system for a number of reasons. I felt that a commitment to this project would divert NASA's resources from its more fundamental goals of space science and applications and that public apathy would make it difficult for NASA to muster the larger budgets required to simultaneously meet those goals while being able to make full use of the enormous growth in the capacity of Earth-to-orbit transportation offered by the Space Shuttle. At present, the bulk of development funds for the Space Shuttle has been spent and it is currently in the test flight phase. In my opinion, it would be unwise to stop this project under any circumstances that I could imagine.

Nevertheless, some of my predictions appear to have come true. Over the past several years, worthwhile programs have been cut back severely-particularly planetary exploration and advanced studies. Public interest in the space program has not been strong. "Apathy is NASA's Biggest Foe" is the title of an article written by Jonathan Spivak in the February *25. 1977, Wall Street Journal.* "NASA itself," writes Spivak," has failed to advance its own causes effectively." The search for meaningful major goals in space exploration and exploitation will undoubtedly be a major task for your Subcommittee under its new jurisdiction. At present, finding a unified long term objective for full and efficient use of the Space Shuttle seems to be difficult or elusive.

Rather than trying to probe the reasons underlying this perception, I would like to emphasize a major theme which is just beginning to receive serious consideration. The concept I will be discussing is well-matched to the capabilities of the Space Shuttle during the 1980s and 1990s. and would require no major new development in Earth-to-space transportation. If tests prove out existing studies, a large share of the nation's energy problem may be solved by the turn of the century. The implications are potentially enormous.

The concept, first proposed by my Princeton colleague, Gerard K. O'Neill, suggests that the cost of retrieval of resources from the Moon or asteroids is far less than that from the deep gravity well of the Earth. These non-terrestrial materials would be processed in space by continuous solar energy into satellite solar power stations, which would supply to the Earth central station electricity by microwave link from geosynchronous orbit. Economic analyses suggest a favorable cost-benefit ratio for delivered electricity when compared to coal and nuclear power, and the environmental cost appears to be far less.

It may be surprising, at first glance, to find that such a project could be undertaken over the next 10 to 20 years within the constraints of NASA's current annual budget, and that no major new technology development is required. Yet studies continue to show these to be facts. A step-by-step program could be developed which could demonstrate the concept before a final, irrevocable decision involving billions of dollars would be made.

The problem is in having the foresight to take the first critical steps in determining whether such a program is entirely feasible and worthwhile. Unfortunately, the current trend is in the other direction. Satellite solar power and space industrialization are the subjects of recent and ongoing NASA studies, but the few million dollars of funding allocated to these studies has been cut back this year. A Lunar Polar Orbiter resource prospecting mission proposed by NASA is also in jeopardy. And the work which has begun to synthesize these three areas-prospecting, industrial operations in space and satellite solar power-has been funded at the $100,000 level with major unanswered questions being postponed indefinitely from year to year. I believe it reasonable to conclude that a lack of foresight in allocating such a small fraction of the nation's space budget to making a thorough assessment of a potentially vital energy option constitutes a lack of public responsibility.

If this concept appears to be feasible and in the public interest, a decision in favor of its development would have several positive effects: (1) it would solve a large gap in world energy supply during a period of dwindling non-renewable resources, serious threats to the environment and international stress; (2) the achievement of self-sufficiency in space could lead to outlets for human survival and opportunities for exploration; (3) it would help redress balance of payments imbalances and free the United States from dependence on Arab oil; (4) it would provide continuity and challenge for the nation's aerospace talent which contributed so effectively to the achievement of Apollo; and (5) space would again capture the public imagination, tapping what I feel to be a pervasive, though currently latent, constituency. Over the past year, about 5,000 inquiries have been directed to us in Princeton about our work.

To give an example of what could happen as early as the 1980s. I would like to describe a scenario which is the subject of a special symposium, "New Moons: Towing Asteroids into Earth Orbits for Exploration and Exploitation," held at the Eighth Annual Lunar Science Conference in Houston. The scenario starts with the launch from Earth of a long, narrow solar-powered electric motor called the mass driver, a device which is currently under development. Fifty weekly shuttle flights would be required. The motor is assembled in a low Earth orbit, then is launched on a trajectory toward a nearby asteroid. With a rather low expenditure of energy, the motor reaches the asteroid and slowly tugs it into a very high orbit around the Earth. By 1990, this "new moon," weighing several million tons, could begin to be processed into enough satellite solar power stations to meet a significant portion of the nation's increased demand for electricity at the turn of the century. The total cost would be many times less than the several hundred billion dollars of proposed capital expansion of coal and nuclear power plants, even under the most conservation-minded extrapolations in electricity demand.

It is tempting to dismiss these scenarios as speculative fiction. But the studies are indicating the reverse. There are numerous historical analogies to unexpected developments in technology. The Apollo Program, for example, was successfully carried out from its inception in eight years within its planned budget.

(Continued on page 20)

WHAT'S AVAILABLE FROM THE L-5 SOCIETY?

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Reprints:

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"Colonies in Space," *Time,* June 3, 1974.	P2	$ .07
"Colonization of Space," Richard M. Reiss, *Mercury,* July/August, 1974.	P3	$ .56
"The Colonization of Space, Gerard K. O'Neill, *Physics Today,* September, 1974.	P4	$ .63
"Lagrangia: Pioneering in Space," Gerard K. O'Neill, *Science* News, September 21, 1974.	P5	$ .07
"An Orbiting Solar Power Station," *Sky and Telescope,* April, 1975.	P6	$ .21
"Colonizing the Heavens," Isaac Asimov, *Saturday Review,* June 28, 1975.	P7	$ .35
"The Garden of Feasibility," Gwyneth Cravens, *Harper's Magazine,* August, 1975.	P8	$ .49
"Space Colonies and Energy Supply to the Earth," Gerard K. O'Neill, *Science,* December 5, 1975	P9	$ .35
"Wireless Power Transmission," John F. Mason, *Electronic Design,* December 6, 1975.	P10	$ .14
"Colonies in Space," Ron Chernow, *Smithsonian,* February, 1976.	P11	$ .56
"Moon Mines, Space Factories, and Colony L-5," Michael Guillen, *Science News,* August 21, 1976.	P12	$ .14
"Engineering a Space Manufacturing Center," Gerard K. O'Neill, *Astronautics and Aeronautics,* October, 1976.	P13	$ .70
"The Impact of Space Colonization on World Dynamics," J. Peter Vajk, *Technological Forecasting and Social Change, 1976.*	P14	$ 2.38
"Colonizing Space," *Time,* May 26, 1975.	P15	$ .07
Complete set of reprinted articles.	CP16	$ 7.75

Otherwise Unpublished Papers

"Closed Ecosystems of High Agricultural Yield," H.K. Henson and C.M. Henson, 34 pages.	UP1	$ 2.38
"Space Resources and the Human Race," W.L. Hurd, Jr., 22 pages.	UP2	$ 1.54
"A Preliminary Cost Benefit Analysis of Space Colonization," Mark M. Hopkins, 66 pages.	UP3	$ 4.62
"The Nature of Space Law," Scofield and Morgan, 123 pages.	UP4	$ 8.61
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Set of unpublished materials, excluding the 1976 Summer Study.	CUP7	$17.00

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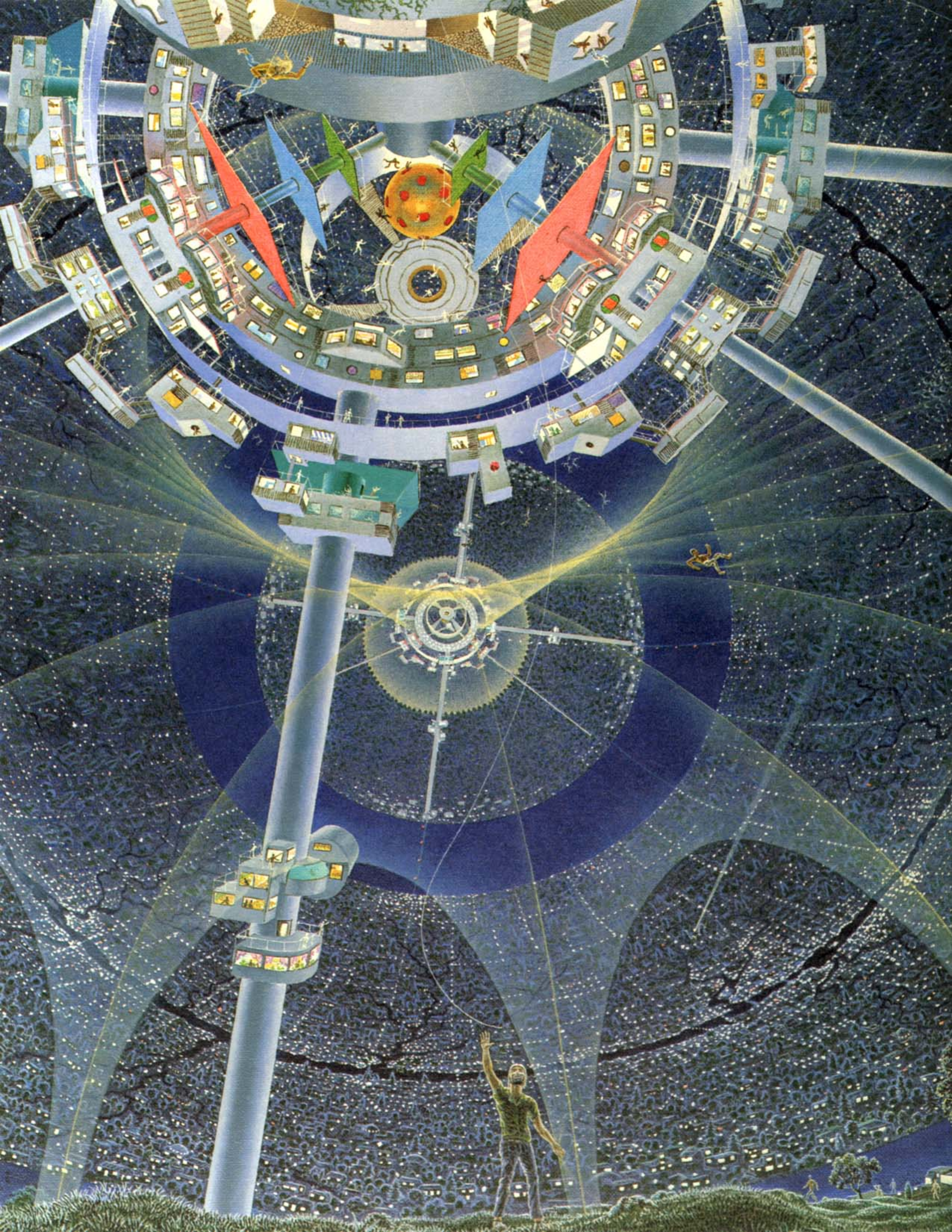
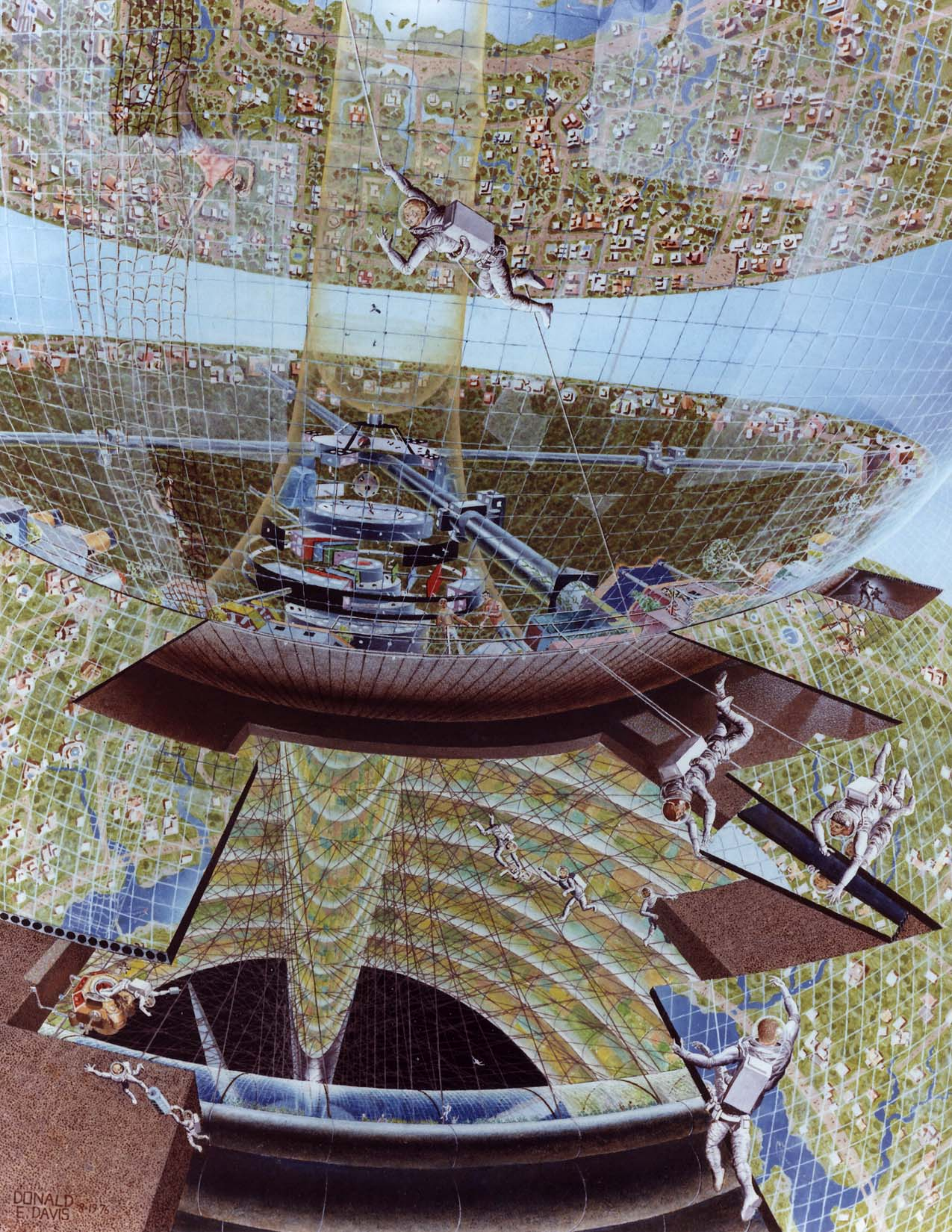
SPECIAL NOTE: *Space Settlements, A Design Study* (the 1975 NASA/Ames Summer Study) is available for $5 from the U.S. Government Printing Office, Washington, D.C. 20402. The stock number is 033-000-00669-1.

Inside center, left: BERNAL SPHERE INTERIOR.

Constructed around the axis of the Bernal Sphere is a series of concentric buildings and galleries. The ceilings point toward the zero-gravity point. A conical net encloses the entire structure (see archlike openings). In this night view, the man in the foreground is standing near the edge of the zero-gravity area. The rope he is reaching for is used for climbing sports. At center right a man is sliding down the net (Painting by Don E. Davis).




DONALD
E. DAVIS
8-1976

WHAT'S AVAILABLE FROM THE L-5 SOCIETY?

Please order these materials by number on the form provided on page 24. For xerographic reprints and otherwise unpublished papers, see page C-1.

Books:

The Hunger of Eve: A Woman's Odyssey Toward the Future, Barbara Marx Hubbard, Stackpole Books, Hardbound, 1976	B1	$ 8.00
The High Frontier: Human Colonies in Space, Gerard K. O'Neill, William Morrow & Co., Hardbound, 1977	B2	$ 8.00
Colonies in Space, T.A. Heppenheimer, Stackpole Books, Hardbound, 1977	B3	$12.00
The Fourth Kingdom, William J. Sauber, Aquari Corp., Hardbound, 1975	B4	$ 6.00
War and Space, Robert Salkeld, Prentice-Hall, Inc., *unbound copy,* 1970	B5	$ 7.00

Back Issues:

L-5 News, Volume 1:1-16, Volume 2:1-4	B2 no.	$ 1.00
Space Settlement, special edition of *L-5 News,* Volume 2:5	B1 2:5	$ 2.00

Postcards:

Bernal Sphere Interior	PC1	$ .15
package of 50	BPC1	$ 3.00
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Slides:

Introduction to the L-5 Concept 18 slides	S1	$ 9.00
Space Industrialization 28 slides	S2	$14.00
Satellite Solar Power Stations 12 slides	S3	$ 6.00
Space Habitats 18 slides	S4	$ 9.00
The L-5 Society Slide Show all 76 slides	CS5	$38.00

All prices are subject to change without notice.

Inside center, right: BERNAL SPHERE ASSEMBLY. The final shielding and mirrors for the Bernal Sphere are being put into place. This view is from the outside of the windows during the day. The cosmic ray shielding in the foreground is a cutaway view. Inside the window, people are in shirtsleeves and are crawling up a net. The concentric buildings and the net that encloses them can be seen at the axis of the Bernal Sphere (Painting by Don E. Davis).

Policy

(Continued from page 3)

Bodies," now in force for over seventy countries (U.S. Treaties and Other International Acts Series 6347). But it is now comparatively old, pre-dating the Moon-landing and O'Neill's synthesis. It has already become the subject of many suggestions for revision (Kash; Christol).

This treaty established the broad principle that "use" of celestial bodies is open to all nations; but neither any territory in outer space nor outer space itself is "subject to national appropriation by claims of sovereignty." Exploration and peaceful experimentation is permitted, but implementation of a space industrialization program of the type and scope envisioned by O'Neill will clearly raise allegations of illegality if any single nation attempts such a program. Certainly the mining of lunar materials and their transport into space for construction purposes is more than a strict reading of the treaty permits; J.H. Glazer has even argued that construction of a fixed-orbit colony might be construed as "national appropriation" of a portion of outer space. A Canadian study in 1967 recommended that Canada claim an area of space for use by synchronous orbit satellites (Johnson), and in December of 1976, a claim to control of geosynchronous orbit space over equatorial states was advanced by a group of eight equatorial nations (Bogota Communique, December 4, 1976). The claim may not stand, but the fact that it has been advanced suggests that large-scale space development may prove Glazer a prophet.

Further, outer space and celestial bodies are reserved by the Treaty for "the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind." This principle seems very close to what the developing nations are demanding in maritime law conferences; clearly space law must deal with this demand in some form.

Christol has proposed an evolutionary approach, involving creation of an international organization to manage space development. He argues that the present vague space regime permits nations or organizations under their supervision to exploit space resources provided only that no claims to sovereignty are made, and that the use made is both peaceful and internationally beneficial. Even so, "the problems of exploiting the natural resources of the space environment is very similar to that posed in the exploitation of the resources of the deep seabed and ocean floor. In each instance there is a need to focus on the management of such resources by way of an operating regime or authority, which, in order to be most effective, would undoubtedly take institutional form." In particular, the pressure for a share in the oceans' benefits coming from developing and non-coastal countries will surely be matched in space development as developing and non-space-traveling nations become aware of potential benefit and seek to channel it in their direction. Institutionalizing the program in an agency subject to international control seems a likely preferred strategy for "have nots"; the space-going nations may resist.

Because of the potential for loss of control, major space-going nations may prefer other alternatives. The similar situation in law of the sea negotiations has produced a warning from William Rogers, U.S. Undersecretary of State for Economic Affairs, that "many of the developing countries are trying to impose a doctrine of total internationalization on the industrial countries, which alone have the technological and financial capacity for mining the seabeds in the foreseeable future. The U.S. has offered to find financing and to transfer the technology to make international mining a reality. But total internationalization is out of the question. . . . There are limits beyond which we cannot and should not go."

> *"A multi-lateral treaty might create a class of internationalized, less-than-sovereign legal entities in space, with sufficient legal capacity to accept limited legal rights and obligations."*

Outright violation of international space law by some great power would be costly, and potentially destabilizing: a national program to acquire exclusive control over important extraterrestrial resources, and to construct large platforms in space, would merely arouse national security fears in other countries. Presumably strong counterpressures would be aroused. But full internationalization seems too much to expect at this time.

Re-interpretation of existing law and principles may, however, permit important space development by some middle road between national exclusivity and an unlikely "space government." Glazer has sought to apply traditional state-centric law to outer space development and has found several possible avenues. Under his flexible interpretation of current law, one possible option would be the resurrection of the concept of a "free city" which was applied to Danzig and Trieste. A multi-lateral treaty might create a class of internationalized, less-than-sovereign legal entities in space, with sufficient legal capacity to accept limited legal rights and obligations. These entities would be neither solely national instruments, nor themselves nations, and would thus neatly evade the problems of "national appropriation" while simultaneously allowing their sponsoring nations to exercise control in the most significant matters. Perhaps NATO, EEC, Comecon, or other multi-national groups could sponsor such a "free city," thus maintaining the existing legal regime while evading broader international control.

Something similar to the "free city" may be in the minds of both O'Neill (1976) and Peter Glaser (1976). They refer to what are probably international, or at least multi-national, space industry operating organizations which seem to resemble the International Telecommunications Satellite Consortium (Intelsat). Intelsat was created by multi-lateral treaty as an "international public utility" to operate and regulate international satellite communications. Such a model might meet legal requirements as postulated by J.H. Glazer, but does present some political and organizational problems, which will be noted below.

Christol, and others drawing on analogies from current sea law controversy, assume that national resource competition in space will not automatically benefit all nations and therefore contemplate the necessity of some variety of international organization to meet demands for greater equity of benefits. Glazer's models would attempt to avoid a future in which space development is "monolithically centralized" by preserving an essentially single-country exploitation model or by creating a special-purpose "loophole" device such as the "free city" for use by groups of nations. Christol's model suffers from the usual infirmities of large international organizations which must be multi-functional, deal with very important matters, and satisfy a broad range of national interest; Glazer's are still likely to spark the rivalry and controversy that would be aroused by unambiguous single nation actions, without providing any offsetting benefits.

A third alternative might build on Glazer's plus the models provided by the U.S. Constitution's separation of powers model and some of the usual features of anti-trust laws. Space colonization and industrial exploitation is clearly a complex, interdependent, specialized enterprise. We may analytically subdivide it in several ways, only one of which -- location of activity -- will be used here for illustrative purposes:

1) Earth-based (at least until well along in the program) activities such as

surface-to-orbit shuttles, managerial coordination, financing, marketing, and industrial production;

2) lunar-based mining and associated operations;

3) colony-based industrial fabrication;

4) satellite power station operations.

Accepting Glazer's premise that it will be easier and just as suitable to adapt existing law rather than to invent new modes, we may construct an "anti-trust" space law regime which permits any one country or international organization to operate in no more than one (or two or three, depending upon the degree of "safety" desired) of the above listed sub-divisions. A central coordinating organization would probably be necessary for efficient operation, but it could be international and could be barred from direct involvement in operating areas. Those who propose measures to control the oil multinationals frequently construct similar models (Blair).

Space exploitation will require extensive interdependence between the several operating divisions listed above, but the "anti-trust" provisions would require their legal and political separation. Under the logic of separated powers, in which each "branch" has a self-interest in both cooperation with the other branches and in checking their unrestrained growth and power, it may be possible to avoid both extremes of "monolithic centralization" and nationalistic aggrandizement. Each member nation should be able to assure that its interests would not be endangered, but a norm of cooperation would be necessary for successful exploitation. The American federal government has operated for two centuries on a similar model: some degree of inefficiency and risk of deadlock has been accepted as the price for prevention of tyrannous government, while the overarching need for cooperation forces compromise. Perhaps a similar, functional division of powers in space can provide a key to both legal and political institution-building. Additionally, such a model automatically spreads financial burdens and benefits across a number of countries, thus easing the problems of raising capital and simplifying the problems of distribution of profits.

Some Organizational and Political Possibilities

The organizational and political devices used for space exploitation will be shaped by, and will continue to shape, the legal model established. Current space law and practice, as well as normal international rivalry, seem to rule out the possibility of some single nation dominating all areas of space industrialization. The 1967 Outer Space Treaty requires that all space activities must be under the "authorization and continuing supervision by the appropriate State Party to the Treaty" (Art. VI), which equally, clearly rules out the possibility of a wide-open private enterprise approach in which governments stand aside. Finally, unless something highly unexpected happens in the theory and practice of world government, there is unlikely to be anything approximating "space government" on the supranational level.

Assuming a space law regime which is neither a single, all-embracing government nor real anarchy, organizations involved in space industrialization must utilize models which are flexible. An international legal regime and its organizational components must work both on Earth and in space, and must work with individuals and groups who will no doubt also remain subject to their own national laws in areas and roles not controlled directly by international space law. A similar condition exists in regard to ocean law, in which individuals may be subject to international law, to the laws of their nation of citizenship, or to the laws of other nations, depending on the particular conditions.

"An international legal regime and its organizational components must work both on Earth and in space . . ."

There is a tendency to extrapolate from existing models of space organization into the future, although this probably will produce an inappropriate model for space industrialization. Existing space organizations deal with narrow functional and usually technical problems: communication satellite operation, resource surveys, meteorology. Although complex, these are relatively impersonal and small scale, focused on technology (Steinhoff). Models of organization which have appeared in space industry literature, such as the "Ensat" (O'Neill, 1976) or "Sunsat" (Glaser, 1973) models, assume a relatively narrow focus, technology-dominated, functional organization held together primarily by economic motivations. There is a clear analogy to Intelsat, the International Telecommunications Satellite Organization.

Skolnikoff (pp. 159-160) has modeled the effective international organization, particularly those which are technology-related, as being characterized by highly specialized and technical subject matter, having a clearly defined and restricted function, with a membership limited to only those nations directly involved in the technology and operation (thus, a small number in most cases), and with an organizational structure allowing representation and control based on the recognition of unequal power, stakes, and expertise of the members. Further, public interest, economic and political stakes would ideally be narrow and limited. In brief, the organization is more administrative than political. Intelsat seems to meet most of these requirements rather well, and has been successful. But can this model apply to space industrialization?

According to the O'Neill scenario, within some thirty years there would be a human population in space numbering at least 10,000 and perhaps as much as a million. Because of the rapid growth capabilities of the system and the presumed great attractiveness of life in space colonies, that number could grow geometrically-into the billions. Certainly, even numbers of people approaching a million would be beyond the scope of Skolnikoff's model: in 1970 more than ten national governments had populations of less than one million, and a majority of the world's nations had fewer than ten million population. This scale of human population suggests that politics will be at least as important as bureaucratic organization.

In addition to sheer numbers of people in space, there is the expectation that very large proportions of national and international energy systems will depend upon satellite solar power. Massive economic stakes will be involved. National, even planetary, economic and social well-being could depend upon the energy, industrial products, and perhaps raw materials produced in space. Simultaneously, according to the plan, the space colonies themselves would be in the process of reducing their dependence on Earth by developing asteroid resources, space agriculture and machine facilities. This reversal of roles, from space colonies dependent on Earth to the opposite condition, will clearly have political consequences.

Something analogous to this process has happened before in human history, in the great colonial migrations of the seventeenth through nineteenth centuries in the Western world, and in other cases throughout recorded history. Colonies begin as administrative, functional organizations, but develop internal and external politics. Parent countries have always insisted upon a significant voice in the affairs of their offspring, and successful colonies usually have sooner or later drawn free. During this process both the colony and the sponsoring nation had to adjust to the development of new economic relationships, new value constellations, new types of both cooperation and friction; that is, to conflict and its resolution by political means. Whether one sees space communities as colonies which will seek liberation, or as economic dependents which will grow in power and eventually rival the mercantilist core powers which established them (Gilpin), there is clearly a potential for rivalry between nations on Earth over control of space industry, between colonies in space, and between Earth and the colonies. The Skolnikoff technology-oriented model is clearly not applicable to space industrialization.

At the opposite extreme would be an organizational mode dominated by representational and economic equity concerns rather than functional expertise, with multi-purpose functions and something approaching universal membership. The organization would deal with high stakes, high public interest, and a complex set of demands. Formation of this organization would be of great significance, since the terms of its charter would be an important part of the stakes. It is not unreasonable to expect development of what approximates a universal government for space to be slow in formation, diluted to a least common denominator, and difficult to work. Indeed, it seems unlikely to happen at all.

Between the Kropotkin-like “mutual aid” of an “Ensat” and the pitfalls of a “space government,” there may be reason to refer again to the “anti-trust” model. This model is essentially a variety of functionalism, proposing that the advantages of cooperation will be sufficient to entice nations into accepting a buffered system within which they cannot control but can prevent others from controlling, and can nonetheless gain the material advantages sought.

Advocates of space industrialization, particularly for energy production, typically cite economic studies indicating that their preferred alternative is less costly than other alternatives, and point to its possibility of very profitable long-term operation. Even though these are good advocacy points, it is still true that any project designed to supply a major proportion of the world’s energy will be enormously expensive. Current space industrialization studies indicate initial costs will run from as low as $40 billion to perhaps $200 billion over twenty-five years, a range of about fifteen to twenty-five percent of what the U.S. electric utilities expect to spend on capital during that same period. In increasingly burdened capital markets, as nations attempt to deal with the capital needs of not only increasingly-expensive energy but a host of other demands, there will probably be great reluctance by any one nation to shoulder an additional capital burden of this size.

There is a history of U.S.-Soviet negotiations on ways to save money by joint space projects, and of somewhat more successful arrangements between the U.S. and several non-communist countries for cost-sharing, such as launches of satellites (Kash). All these projects together would aggregate far less than the minimal initial costs of space industrialization. It is clear that saving money does not always overcome political objections, but it helps (White). For the wealthier nations, there should be a willingness to pay some political price in order to obtain important economic help. The poor nations conversely may be able to pay only a small portion of the economic cost, but be willing to do so in return for some political voice in a program of very great potential importance to them. By dividing the space industry system into several program elements, and organizing economic and political participation around them, it should be possible to accommodate a number of variations in national size, wealth, goals, etc.

> *“Current space industrialization studies indicate initial costs will run from as low as $40 billion to perhaps $200 billion over twenty-five years.”*

An organization composed of and responsible to several different nations, with nationals of several countries involved, should be sufficiently full of security leaks to make it very difficult for any nation to mount a security threat through the space industry system. The complex ramifications of organizational coordination should create sufficient bureaucratic structure and integration to allow nation-states a number of options for normal interest-group maneuvering as part of the check-and-balance system. In brief, the technological motivations of efficiency, economy, and effectiveness may, in this case, require for their political acceptability the use of a political structure capable of frustrating any level of efficient action which might constitute a threat. If space industrialization is to proceed, the political price must be paid.

Summary

It is a curious fact that human societies frequently exhibit an inertia akin to that of physical bodies under Newton’s Laws. Although the advice of Schumacher, Lovins, and others urging a simplified lifestyle and ecological adjustments may be the essence of wisdom, it violates the dominant social paradigm of the industrialized societies which would have to accept and live by it. These societies have demonstrated a preference for social problem solution by means of very large scale, complex technology: nuclear power systems, massive waterworks to move rivers rather than people, supersonic planes rather than a slower pace of life. The energy crisis has brought forth chiefly programs for increased energy supply; population explosions have produced the advice that we should “increase the banquet of life” rather than limit the diners. In view of this observed regularity of human behavior, coupled with the apparent technical and economic feasibility of space industrialization, it seems quite reasonable to believe that this article is dealing with a real future.

We have not been particularly good at dealing prospectively with the socio-political aspects of technological developments, even when they could reasonably have been foreseen long before their arrival. Many of the social and political ramifications of nuclear energy systems, ocean mining technology, computerized personal data systems, and many other recent technologies could have been -- and sometimes were -- foreseen, but little or nothing was done about them until quite late. Technology assessment and forecasting are gaining respectability and attention as means of changing that pattern.

For technological development of the potential importance and comparatively fast time scale of space industrialization, we urgently require simultaneous efforts toward assessment and institution-modeling. This article presents preliminary models for both international law and organization, and a preliminary assessment of some basic national security questions aroused by the concept of space industrialization. No fundamental obstacle to realization of the concept is apparent. Design criteria for central elements of the legal, organizational, and security components of the concept are described. In keeping with Ophuls’ (pp. 228-29) definition of “design” as the approach which seeks to produce an outcome “by establishing criteria to govern the operations of the process so that the desired result will occur more or less automatically, without further human intervention,” I have emphasized basic structural and motivational elements. Thus, the legal structure recommended emphasized incremental change and use of existing national and international legal models; the organizational structure assumes that nations will continue to exhibit nationalist concern for security and participation; the national security model emphasizes the neutralization of the system rather than its active defense.

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Science Court

(Continued from page 5)

good deal about this procedure, Margaret Mead, has said that all social inventions over the course of time are corrupted. It's kind of a pessimistic view, but she isn't really pessimistic, she just notes that this is what happens to social inventions, that in the course of time the people who are devoted to doing the procedure properly move away from front center and others who have other motivations, like making a good living out of this business, move toward front center and give it an entirely different aspect. She has also made good suggestions for slowing that corruption, such as the importance of having a cadre of trained people who supervise this procedure, and who are dedicated to delaying, at least, its corruption.

I think that those who believe such a procedure might have too much authority to some extent balance off those who think you can't make it work at all. While I think both of those arguments have some relevance, they are a little out of phase. At first I think it will be very difficult to make it work at all; later when you've learned to make it work well, or really before then, you should start thinking very seriously about preventing the procedure from being corrupted too quickly.

How did your interest in this procedure first arise?

It arose out of my involvement with the space program in the late 1950s and early 1960s. I was appointed to a committee which was charged with drawing up a space program for the Air Force in the year 1960. I was exposed to a lot of folklore from the early space pioneers, and it became apparent to me that Earth-orbital assembly would be a powerful technique on which all kinds of space adventures could be built. This had been suggested by many of the original pioneers in space thinking, but in that period there was a slogan that tried to compress the differences between American and the Soviet space programs into a few words: that the only things that we lack that the Russians have are bigger boosters. That slogan received enough currency to enable it, in a sense, to drown out the earlier and I think still very sound ideas about Earth-orbital assembly. Nevertheless, this committee, after thinking about it a good deal, reached the conclusion, and I was one of the driving forces, that Earth-orbital assembly was at least as important a direction for the U.S. space program as building bigger boosters. The two were treated more or less equally. Well, this resulted in a committee report which had no classified information in it at all. It reached the White House where there was a space council set up at that time. We received the instruction that there were to be twenty-five copies of this only, they were all to be classified top secret, and all twenty-five were to be locked up in the safe in the executive office of the White House, in which as far as I know they remain to this day.

That persuaded me that there was something quite wrong with this whole system. I tried other routes. I went to the members of the president's science advisory committee (I knew some of them personally) and undertook to convince them that if we were going to the Moon, which was then under discussion, we could do it at least ten times more cheaply with Earth-orbital assembly than the way it was being done. We had boosters in Atlas and Titan which could put stuff into low Earth orbit at about a thousand dollars a pound. The price is of course almost unchanged today, although in different dollars. You needed about 250,000 pounds in orbit to do the Apollo kind of mission, which would have cost 250 million dollars. This is a tremendous difference from the twenty billion that it did cost. Maybe you'd have to launch a good deal more stuff into orbit, more than the quarter of a million pounds, to allow for Earth-orbital laboratories, assembly stations, and what have you. Maybe it would have cost ten times that much, two and a half billion, but I don't see how it could have cost twenty billion dollars. I undertook to convince people of this. While I managed to convince a considerable number of scientists, I discovered that I couldn't have any influence on the policy, nor could I get a proper hearing, even though at that time I was known to the space community because of my work on reentry. That persuaded me that we needed a new institution, and so I gave it a good deal of thought. By 1967 I had published it in several places, and I started to try to persuade the Congress of its validity, with thus far no visible success.

What progress has been made towards testing the science court idea?

It has attracted a certain amount of attention, and some people have been kind enough to say that it is an educational notion. Whether or not it will receive the attention needed for the development of a new procedure is still problematic, though several universities are preparing proposals for the National Science Foundation, which has said that it has some interest in funding experimental trials of this procedure. I would hope that the next year or two will see half a dozen such attempts to try it out and develop the procedure to the point where it can be of some use.

Boeing on SPS

(Continued from page 9)

the possibility of using extra-terrestrial materials in the things we publish.

Woodcock: I find some interesting parallels between the L-5 Society and the American Rocket Society in the 1920s and 1930s.

Norie: For example?

Woodcock: Well, the American Rocket Society of those days evolved into the AIAA. It started out as a group of enthusiasts for a very new technology who were regarded by most people as a bunch of nuts. . . and which evolved over a period of years into a major industry and one of the most respected technical societies.

Norie: Makes you think of. . . wasn't it Copernicus? Wasn't he the one who was considered pretty much of a kook and had to recant or else face death?

Woodcock: No, you're thinking of Galileo. Copernicus never fell into that trap. He was the guy who understood the political system well enough not to publish his book until he was on his deathbed.

Carolyn: Well, I guess we have to admit we've come a long way.

Woodcock: Yes, a long way politically from the days when people could get burned at the stake for having revolutionary ideas, particularly when they are religious and philosophical ones.

Norie: Would you have any suggestions of how a group like L-5 might be able to improve its credibility gap?

Woodcock: I think what you have to do is fairly simple. You try to make an appointment with some of the people you have in mind and tell them what it is that you want to talk about. And then talk and get to know them on a personal basis. That's by far the most effective means of communication of ideas, particularly with someone who isn't necessarily very receptive to the idea. If he gets to know you personally and you don't seem like such a strange type after all, then he might decide that your ideas may not be so strange, either, and might bear some careful looking into.

Nansen: Using space solar power as a national goal addresses every single major problem the country has. In the economic area it creates significant jobs simply because it puts money into labor-intensive industry and you get a high ricochet effect of creating more jobs because of that. It's the highest of any industry. It's going into the high technical industry which addresses the fundamental attack against inflation. One of the key ways to grow without inflation is to increase productivity. That's a fundamental feature, and the only way you can increase productivity is to raise the level of technology. Therefore any activities that address high technology in a large way attack the fundamentals of stopping inflation.

And, of course, the next thing is that it is a fundamental attack on the energy problem looking at an inexhaustible source with essentially an infinite capacity that can be competitive with other sources and can eventually be a solution to the energy problem. Another feature is that because it is high technology and would develop the basic utilization of space for practical purposes, it also helps our position in the world relative to other nations. A lot of the potential technologies developed are useful not only in the civil side of our country's activities but in the military also. So there are some secondary benefits.

Norie: Don't you think that the military possibilities are something that might scare a lot of citizens away? They certainly scare *me!*

Nansen: It's possible if you think of some of the potential ways of using it, but we're looking at it strictly as a commercial utilization to develop commercial power. Solar power has a characteristic very similar to hydroelectric power in that after you amortize your capital investment, there are no fuel costs; therefore, you can potentially get your power costs very low if the system works as we foresee it. And also that particular feature is very important to holding down all energy costs. Right now all our energy is essentially generated by depletable finite sources and so with increasing demand and decreasing resources, the inevitable result is rising prices. They will continue to rise -- and I think there isn't any way to stop them -- until you develop an inexhaustible source that will put a lid on it. As soon as you develop an inexhaustible energy source to the point where it is practical, then you essentially put a lid on energy price growth on other sources as well.

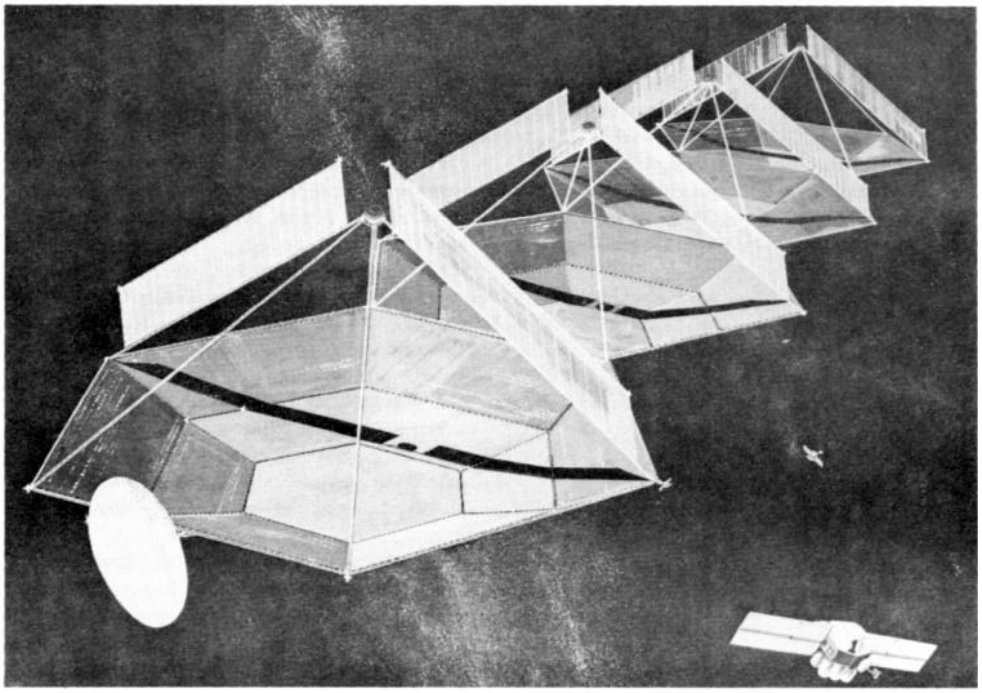
Norie: They have to be competitive?

Nansen: Right. Therefore as a national goal it seems practically ideal. There is hardly any drawback that we can see. Environmentally it's clean. It has everything going for it.

Norie: Have you come in contact with the book *Small Is Beautiful,* by E.F. Schumacher?

Nansen: No, I'm not familiar with it.

Norie: You might be interested in checking it out. It's a beautiful statement about the need for changing the direction of modern society and deals, in part, with the concept of having small, locally based factories using intermediate rather than high technologies, to support the local population and to increase the self-sufficiency of the local area. Would you see these two systems as potentially being compatible?



Boeing's Photo-thermal Solar Power Satellite Design

Nansen: Yes. With this kind of power, you can bring the power to the area in which you want to use it. You're not tied to any region or any specific area. You don't have to bring the industry to where the power is available, you can just bring the power out to where you want your factory, for example, in the midwest. There is really no big natural power generating source in the midwest, and, therefore, the Dakotas lack a lot of heavy industry, simply because they don't have readily available energy for them. So they have the opportunity with this kind of system to spread the base out.

Norie: How about wind or ground-based solar?

Nansen: If development in this program follows in the typical fashion of programs like this, it would stumble along for quite a few years gradually increasing in activity levels but it would take a long time, simply because the basic power generating system is not scaleable. You can't scale SPS down to small units and get a useful amount of power. To make it pay, you have to go to a big investment, and in order to do it, you need to develop not only the power generating system, but you also need to develop the transportation system, the baseline for operations. You need to develop man's capability to live, work and operate in space. So you have a whole bunch of parallel activities. Now the only way that you can really make that kind of progress happen, traditionally, is to make a very large commitment in the massive investment required to make the whole thing happen. Now the only way you can do that is essentially to make it a national goal. Otherwise, you can't get the necessary funding over a short period of time which is really required to bring something like this into being. And fortunately it is the kind of system that will have payback to all the people. It is not a product that is selective to a few individuals that get the benefits. In this case, everyone in the nation, and ultimately in the world, would receive benefit from it. Therefore, it has the ability to have personal appeal that will encourage their support for a massive investment. And all of the kinds of exciting and big things we've done have gone like this. For example, going to the Moon. There was a situation in which everything had to be developed. I believe it was May of 1961 that Kennedy made the announcement that we'd get to the Moon within the decade. Well, at the end of that year every single major element of the Saturn-Apollo program was under contract. It moved fantastically fast. The whole industry was mobilized. NASA was mobilized.

Carolyn: Did they think of the lunar module concept that early?

Nansen: It was very sketchy. The technical base in 1961 for landing on the Moon was not as good as it is today for space solar power. We believe we are further along and know more about space solar power today than we did about going to the Moon in 1961.

Woodcock: Both Ralph and I were in on the early phase days of the Apollo program so we are speaking from a certain perspective on this thing.

Nansen: Yes, we were there from the very beginning. We landed in 1969 in eight years with a program of about the size and development effort that we're talking about here with space solar power. So you can conceive of doing the first basic step of this thing in as short as eight years, if we went at the pace of the Apollo. And, as a matter of fact, in most ways, that is the cheapest way to do something on a massive scale-to do it as fast as you can. You waste some money, but the overall savings generally are much greater.

Carolyn: I don't understand what you mean by overall savings.

Nansen: Well, when you gear up an industry, you have 100,000 or 200,000 people directly working on the program. Now if you are going as fast as you can and pushing them really hard, then the block of time you're going to employ those 200,000 people is eight years. Whereas, if you do things slowly and orderly, you might not have 200,000 people. You might have 150,000 people and take twenty years instead. So every day you have that work force and are paying them during the development period is money that goes into the program without any economic returns. So the faster you do it the fewer days you have to pay them during the period you're still getting nothing back. You can therefore reduce development costs by reducing the time it takes you to do the job. to a point. After all, if you go too fast, then you waste things and make mistakes. But generally speaking the quickest you can do it is the cheapest.

Woodcock: I think the comparison you want to make-using the Apollo time frame, which is the best comparison we have for this kind of program-is that this is about how long it would take you to establish a construction facility. Then you could start to construct the first satellite and there would be a little bit more time to go through the construction. In this kind of a commercial program it probably makes sense to go to a prototype for redesign and reconstruction before you go into actual production. That is, by the way, exactly what we do in the commercial airplane business, especially the 707. The first commercial jet transport was a hand built prototype and from that we learned enough about what the design should be to go into production. Now we go directly into production on commercial aircraft.

Norie: One thing I'm quite interested in is the potential for international cooperation in this whole area. I should think that the Japanese with their energy crisis would be extremely interested in getting involved in this and would also have a lot to offer in electronics and other fields.

Nansen: As a matter of fact, this system has so many components and subsystems involved that many of these could be broken down and development could be semi-independent of other things. For example, the thermal engine satellite, where each individual mirror facet has to be steered individually and it needs to track the Sun and the cavity absorber and direct sunlight there, and it has to be able to move through a small number of degrees to correct for any inaccuracies in the basic satellite pointing or in deflection of the structure. So there are sensing units and actuators there to steer these facets that would be a representative sort of thing that a country like Japan would produce because it involves a small sensing system of some type, undoubtedly electronic, and a drive system. And they will be required by the thousands-pretty near millions when you look at a production run of satellites. So a country like Japan with its high rate of production of solid state devices would be ideal.

There all kinds of systems of this nature-engine systems, generator systems-when you're talking about thermal satellites or photovoltaic systems, switchgears or photocells, antenna elements.

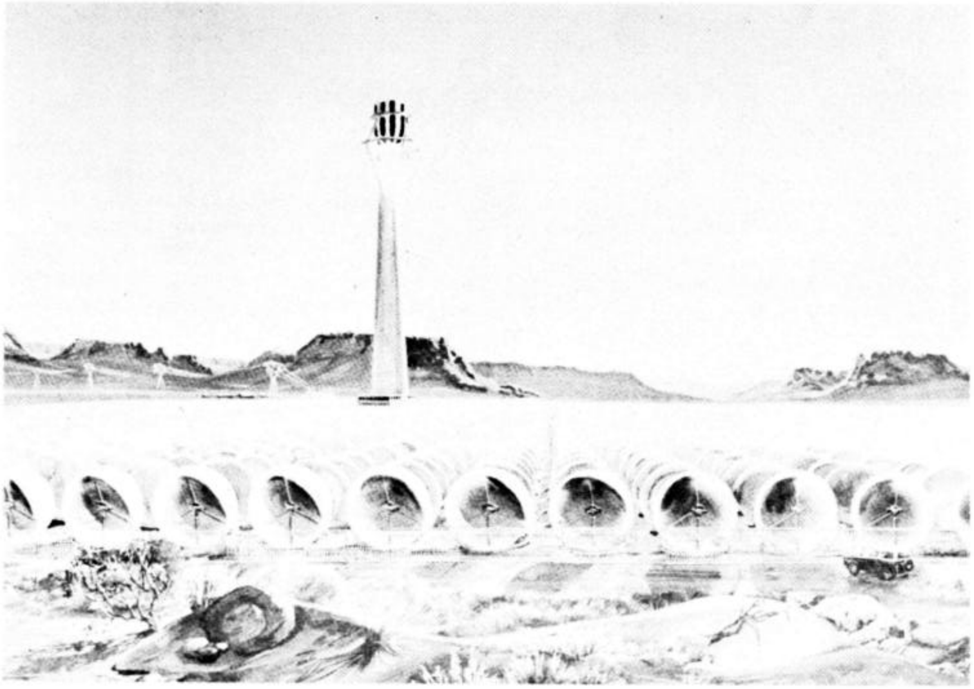
Woodcock: It's really hard to imagine a program like this getting off the ground without some element of international cooperation.

Nansen: Orbit locations, potential traffic control, and similar issues will certainly require new international agreements. That much power going into microwaves and the potential of radio interference has to be considered throughout the world, not just in the U.S. Some basic international agreements have to be reached.

Woodcock: Let me point out one thing about inexhaustible energy sources -- this one or any other -- that is a very powerful economic consideration. In the past half dozen or so years, we have seen a not steady but monotonical increase in the cost of energy. One reason is that the sources are finite and getting more and more finite all the time; the cost has nowhere to go but up. Provided you have the kinds of characteristics that we have in SPS (e.g., no capacity limit), the source of energy is free and non-depletable and the cost is in the device that collects the energy. As soon as you get a practical system on line, then the cost of energy will go down, because then you'll get better and better at it. As you get better at it, then you can make things cheaper, and since the source is not limited in any reasonable, practical sense, that would probably make a big contribution to this problem of inflation which some economists believe is basically driven by the cost of energy and not by other things.

Nansen: Well, it attacks it two ways. It attacks it for the reason Gordy stated which is the relation between basic energy cost and inflation. Plus it increases the technology level which increases productivity and that is the key source of national growth without inflation. You have to increase productivity or you cannot do that. So we address inflation from two directions.

Woodcock: It's possible in the economic world to regard inflation as a tax. It's the most regressive tax of all, more regressive than the sales tax. If you really look at how inflation hits different sectors of the economy, the people with the least income are hurt by it the most.



Boeing's Ground-based Solar "Power Tower"

The people with the most income are hurt by it the least and some may be helped.

Norie: In the new Carter administration there's a lot of talk given to the problem of inflation. Has there been any attempt to get in touch with people in the Carter administration to find out their feelings about this whole program?

Woodcock: We haven't made any real attempts yet. The administration is pretty busy right now just getting into office. But certainly this type of thing should be very appealing to him because it addresses the kinds of things that he has been saying that he is going to do. It addresses just about every problem he said he wants to tackle and it also is a dynamic, exciting adventure that I think would be very appealing. So we expect a good response, but we haven't tried yet.

Norie: It seems that one of the big differences between what you're exploring and what the L-5 Society is interested in has to do with the use of extra-terrestrial materials. I guess you are taking a more conservative approach.

Woodcock: (pause) I guess you could call it more conservative.

Carolyn: I guess you're not accustomed to being called conservative!

Woodcock: (laughing) No. Shall we say that the program we at Boeing advocate involves a good deal less technical uncertainty to make the thing work.

Nansen: We're trying to lay out a basic system that you can look at today and say, yes, we can do every single technical aspect of that. We have proven in some way or another that we can do each one of the things we're talking about. And you can't say that today if you start talking about using materials from the Moon. This doesn't mean that someday that's not going to be practical. It's just that we don't have the technology at hand and, frankly, what we're looking at is a close-in start to attack the energy problem with our program.

Norie: In other words, you want something that has very high credibility. .

Nansen: Yes.

Norie: . . . at every step of the way.

Nansen: That's right.

Norie: And then after you get there. .

Nansen: Then you can improve it, or explore other possibilities. We're trying to start from a known position, and then find how to make it better with the unknown.

Norie: That seems reasonable considering the way the government works.

Nansen: Yes, it has to be practical. You see, the period that either most people or the government would accept a large investment in space-to explore or develop-is gone. We have gone through our "exciting period" in space. This happens in every field. Now what we're faced with is this: if we want to proceed, we've got to do something practical, something with economical return. It has got to be a utilitarian operation. So in order to do the other exciting things, you've got to have somebody pay the bill. And the best way to pay it is to develop a good source of income. That's what the SPS program represents. And at the same time, it would develop the capabilities of the transportation system, the capability to live and operate in space. It would give us the opportunity to go do other things at very minimal cost because you've made your major investment in the tools.

Carolyn: Could you give us a ballpark figure of the investment in R&D as well as the capital investment to get your first operational satellite sending power in bus bars?

Nansen: Well, you don't have a good hard number, but you can kind of estimate it if you look at the Saturn-Apollo program if you escalated it to today's inflated dollar. That's about the development bill. As for the capital cost, there's quite a range, as Gordon said earlier. But it looks as if it is not significantly higher than the projected costs of new nuclear plants, the breeder reactor type. It's about that range of capital cost in terms of dollars per installed kilowatt hour of generating capability.

Norie: On Project America, we visited Los Alamos and were given a very interesting presentation by one of the scientists there about possible forms of energy in the future. Their emphasis is on nuclear fusion. According to the man who talked with us, they had heard a discussion on the solar space satellite concept, and they rejected it on the basis of cost. As I remember it, they said it would cost too much to put the things in orbit.

Nansen: Oh, the first time most people look at our satellite program they say the same thing simply because they're equating today's space costs of communication satellites. A communication satellite may cost $10,000 a pound because they are small, complex systems, one of a kind with very sophisticated (dense) electronical packaging and today's transportation costs are $600 a pound.

Woodcock: To get it into geosynchronous orbit today is about $5,000 a pound.

Nansen: So when you extrapolate these kinds of costs-and that's what people do who don't understand the system-then it's totally unfeasible. But when you tackle these problems and lay out the kind of system we have, then it becomes totally different. It is a commercial venture of a completely different order of magnitude.

Woodcock: The usual way of dispensing with the SPS concept is to say that the cost of transporting into geosynchronous orbit is $10,000 per kilogram, which is about right for the Titan III, and that the satellites by the most recent publications weigh about ten kilograms per kilowatt. So all you have to do is multiply those two numbers together and you come out with $100,000 per kilowatt. And that is clearly not an acceptable cost. That's about the amount of consideration that the concept gets from lots of people.

Norie: Is that perhaps because they have a competing scheme and don't want to give you any more consideration?

Woodcock: I'm not sure that's generally true. I think that when people think about space-and they've got plenty of reason to think this-they think of something that's exotic, exciting, and certainly expensive. There are some very fine and historical parallels in that area. One can find statements made by people who should have known better-by that I mean physicists, aerodynamicists and so forth-a few years after the Wright brothers and when airplanes were already flying. They said, it's conceivable that airplanes could be developed to the point where one could somehow struggle across the Atlantic with a few passengers, but that the costs would be so exorbitant that no one could afford it except the rich capitalist who could afford to own his own yacht; that visions of fleets of giant aircraft carrying ordinary people great distances across the Atlantic have just got to be wholly visionary. There is no way that is ever going to happen. Now, this statement was made about 1910, after airplanes were flying. Another quote was made in 1926 by, I believe, an astronomer. And this was after Goddard's first rocket flight had been published. Of course, Goddard had written a book in 1919 in which he said that one might conceivably send a rocket to the Moon and this guy went through a little bit of arithmetic to show, as one can readily do, that the energy per unit mass of something that is going to escape the Earth is far greater than the caloric content of any known fuel. And he said that for this reason the idea of shooting things at the Moon was obviously ridiculous. It simply gives an example of the irrationality that extreme specialization will carry some scientists to! You can find more quotations of that nature than you can find space to print them. One of the best sources of many of them was a book published some years ago called *Profiles of the Future* by Arthur C. Clarke.

To go back to costs, another point is that in the early phases of a program cost estimates tend to be low. There's good reason for it. It's not that people are liars or that they're incompetent or ignorant. It's simply that in the early days of a program designed to accomplish a major objective, one is unable to identify all the elements of the program.

Norie: Could you point to some of the spinoffs of the space program so far?

Woodcock: There are lots of them. All kinds. Some of them direct, some of them pretty indirect. I think the whole miniature computer essentially happened because of Apollo, pocket calculators. . .

Nansen: It's fascinating to think that if you could get in a time machine and go back about thirty years and show one of these pocket calculators to a reasonably competent engineer or scientist, he would have had to conclude that it works by magic!

Norie: Could you comment on the problems of maintenance and repair of the SPS? Would there be a problem of meteors crashing into it, etc.?

Woodcock: Major damage would be fairly negligible because it would require considerable impact. It isn't a significant economic factor. Minor damage would be expected on a routine basis and would have to be repaired. That seems to be a second or third order factor in terms of expense.

Interestingly enough, if you look at the flux of large objects-by that I mean meteorites larger than the typical pea-sized meteorite -- the natural flux of objects of near -- Earth space is far less than the flux of manmade objects. And there is a problem of collisions between man made objects and things as large as the SPS. This is currently under evaluation.

Norie: Do you mean man made objects like satellites?

Woodcock: Satellites, too but most notably junk. When a satellite is launched, there is usually one active satellite and several pieces of junk like spent stages, shrouds and separation mechanisms.

. . .Congress

(Continued from page 12)

To have contemplated its completion within twelve years of the launch of Sputnik in 1957 would have appeared heretical.

I am proposing the open discussion, timely funding and systematic progression of a concept which would have enormous implications for this nation and the human race. With this goal in mind, I have the following recommendations for the Committee's consideration in dealing with NASA and Carter Administration during the next few years:

(1) Work with NASA to identify those long term goals which are consistent with the public interest and are of fundamental importance.

(2) Help clarify agency jurisdictional problems. For example, the lines of responsibility for satellite solar power between NASA and ERDA are not clear and may be retarding a timely study of the concept. The capabilities of NASA in this area, in my opinion, are extraordinarily strong.

(3) In order that informed decisions be made, use the Committee's power of authorization in restoring vigor to the most promising programs which have long lead times, which require study and development, and which may develop into a major activity. This would include opening a dialogue with the Office of Management and Budget and reversing some of their decisions-for example, cuts in the modest funding of satellite power, space industrialization and the Lunar Polar Orbiter.

(4) Take part in presenting to the American people those options which appear to be most promising once they have been studied and partially developed.

(5) Participate in debates and decisions on these issues after the data are made available.

I hope you agree with me that an exciting concept has been developed. For the first time in history, the vast quantity of energy and materials available to us in space present an imaginative and practical new outlet for human experience.

news

CLOSED ECOLOGY TESTED FOR SPACE

Science News

Permanent colonies in space, Earth-orbiting stations and piloted flights to other planets are all possible applications for life-support systems that function as closed ecologies, providing air, water and food through a variety of mutually dependent biological systems. A recent Soviet test sustained three people for six months in a system that provided oxygen by recovery from atmospheric carbon dioxide, water from "photosynthetic regenerative process" and included the production of "a certain amount of grain and vegetables." The result, according to I.I. Gitelson and colleagues from the Soviet Academy of Sciences, "established beyond question that a small, steadily operating, essentially closed system of 'substance-turnover' involving man is quite feasible. . . ."

LUNA 24 SAMPLES INSPECTED

Three U.S. lunar scientists (Dr. Michael B. Duke, NASA/Johnson Space Center; Dr. G.J. Wasserburg, California Institute of Technology; and Dr. Charles H. Simonds, Lunar Science Institute), visited Moscow on December 13-15 to examine lunar materials returned by the Luna 24 mission last August and to arrange for the transmission of samples for study by U.S. researchers. Luna 24 returned a 2 meter long, 8 millimeter diameter core from southeastern Mare Crisium, which has not been sampled previously by U.S. or Soviet missions. The site may contain material from nearby highlands and material from the ray crater Giordano Bruno some 1200 kilometers away.

A Soviet-American space cooperation agreement provides for the exchange of samples from each of the lunar returns. The U.S. has provided 3 grams of sample from each of the six Apollo missions; the Russians have reciprocated with 3 grams of Luna 16 and 2 grams of Luna 20 samples, plus two small fragments of Luna 20 rock provided separately.

Considering the fact that the Russians return has been 100 and 50 grams, respectively, for Luna 16 and 20, their cooperation in this exchange has been exceptional.

ERDA

ERDA, NASA SANCTION LARGE SCALE WIND POWER PROJECT

The following is an announcement from ERDA that details a windpower project that has been funded. Of interest to space enthusiasts is the scale of the project.

A huge rotor blade, half the length of a football field, will be built in 1977 as part of the Energy Research and Development Administration's (ERDA) program to develop a new generation of wind energy conversion systems.

Under the program direction of ERDA, the National Aeronautics and Space Administration's Lewis Research Center, Cleveland, Ohio, has selected the Kaman Aerospace Corporation of Bloomfield, Connecticut for negotiation of a contract for about $2 million to fabricate the 150-foot blade.

The purpose of the contract is to determine if a blade this size can be built and handled. Rotor blades of this nature and size have never been built before. Two blades of this size, spanning 300 feet or approximately the length of a football field, would be needed for a wind turbine rated at about two megawatts of electric power for a site with average wind speeds of 14 miles per hour.

Detailed design studies of such wind turbines are scheduled to begin later this year. By the time the large blade has been built and tested, and design studies have been completed, ERDA and NASA will have enough data to determine the course of the future test program for wind turbines of this size.

Wind turbines this large would be larger than the existing 100 kw experimental wind turbine in Ohio, which has blades spanning 125 feet, and the two 200 kw wind turbines of the same size which are scheduled to be built in 1977-79.

They would also be larger than the two 1.5 megawatt wind machines being designed and built for ERDA and NASA by the General Electric Co. for installation and testing in 1978-80. ERDA is pursuing development of even larger wind machines because studies show that the cost of energy decreases with increasing the size of the machine.

Construction methods used in building this large blade will derive from methods for building helicopter blades. The largest helicopter blade in use is about 55 feet long.

Kaman's rotor blade will be made primarily of glass fiber and will weigh about 12 tons. It will undergo static and dynamic testing at the company's Connecticut plant.

SOLAR ENERGY ABSTRACT JOURNAL AVAILABLE

Solar Energy Update, a monthly abstract journal from the Energy Research and Development Administration (ERDA), has been made available on a subscription basis.

The journal abstracts and indexes reports, journal articles, conference proceedings, patents, theses and monographs on solar energy, including photovoltaic, solar thermal, and ocean thermal power plants, tidal power and wind energy.

Solar Energy Update (NTISUB/c/145) for 1977 is available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161 for $27.50 a year, including a cumulative index. Single copies may be purchased for $3.25. Subscription rate for outside the North American continent is $40 a year and $6.50 for single copies.

Solar Energy Update is intended to be an ongoing supplement to *Solar Energy: A Bibliography,* which contains references to information entered into ERDA's Technical Information Center data base before 1976. Stock number and price of this bibliography are as follows: TID-3351-RIP1 (Volume 1, Citations) -- $13.75 for domestic and $27.50 for foreign; TID-3351-RIP1 (Volume 2, Indexes) -- $11.00 for domestic and $22.00 for foreign.

inside the L-5 Society

NEW COORDINATOR FOR L-5 SOCIETY, Western Europe

The West European Branch of the L-5 Society has a new coordinator and membership secretary, and a new secretarial address. Please send all membership correspondence, dues, requests, and items for the branch or international news magazines to:

Roger Sansom
L-5 Society (WE) Coordinator
45 Wedgwood Drive,
Lilliputt, Nr. Poole,
Dorset, United Kingdom.

The WE Branch has begun to reissue the Branch Newsletter and does hope to issue a regular monthly edition again.

"I believe that the Branch can look forward to another exciting twelve months as we pioneer the items that will be needed for the space community and space industry programs of the next few decades." --Phillip J. Parker, outgoing coordinator.

Stewart Nozette, L-5 member from Tucson, gives a lecture on space at the Museum of Science and Industry in Chicago.

FROM THE OFFICE

Space Settlement, the new quarterly special edition of the *L-5 News* begins with this issue. Advertising space will be available in *Space Settlement* in future issues. For information regarding rates, circulation and other information, please write: Advertising, *Space Settlement,* 1620 N. Park Avenue, Tucson AZ 85719.

The staff hopes you like this long issue. The Don Davis paintings were put inside so you can take them out easily. If you want to see more issues like this one, take *Space Settlement* down to your local library and get them to subscribe. Next month's *L-5 News* will be shorter, but will be filled with exciting news from the Princeton conference (it seems that about 10 percent of our members will be there). Printing some of Eric Drexler's latest work on solar sails is also being considered.

NASA 1975 SUMMER STUDY

The NASA 1975 summer study, *Space Settlements, A Design Study,* is out! The information is somewhat out of date (which is unavoidable on a topic that evolves this fast), but the printing and graphics are absolutely first rate. There are eight beautiful color plates in this 8½ by 11, 185-page book with a color cover. At $5.00, this has to rate as the bargain of the year. The editors, Richard Johnson and Charles Holbrow, NASA and the GPO have certainly done an excellent job on this.

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Short reviews of recent articles will be featured regularly in the bibliography update, as well as mention of books and periodicals about space.

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(Cont'd. from inside front cover)

I was wondering if solar power by microwave beam heats the Earth. Both nuclear and fossil energies do: nuclear through its wastes into the ocean and fossil fuel by the greenhouse effect. The heat these energies give off will melt the ice caps and flood many major cities of the world. If solar power via microwave doesn't heat the Earth, this gives solar panels in space one more advantage over its counterparts.

Richard Hankins
La Mesa, California

After this last winter, melting the icecaps seems a good deal less likely.
All *energy sources heat the Earth, solar via microwave heats it less than nuclear or coal (waste heat is radiated in space). However, human energy use is still very, very small in comparison to the solar flux.* **--K** H

I completely agree with Barbara Hubbard's comments in the January *L-5 News* under "Why Space Now?" It is a question of timing whether we go into space colonization now or later in view of the energy situation on Earth. I hope we pick up the option now instead of procrastinating until the time comes when we realize we do not have the energy to emigrate. If the present trend continues, which seems very likely, more and more of our energies are going into maintenance channels for things like subsistence and less into developmental areas.

There is another point I would like to mention in favor of going out now and that is from a competitive standpoint as viewing Earth against the background of the cosmic community. This may at first seem a shaky basis to support the massive effort involved in space colonization since we have not as yet come into contact with another culture. Statistically, the question was answered long ago and projects to communicate with them are proliferating at a greater rate than are our preparations to *meet* another culture.

I would rather see more of this energy going into channels that will get us out to them rather than have them meet us for purposes of colonization. We should be thinking more along lines of becoming technological equals or we might find ourselves in a satellite status relative to the cultures who were energetic enough to make it.

I very strongly agree with the remarks of Dr. Leary in this regard and think that the impulse for this venture should be generated from the "grass roots" level. If the project is approached through institutional and bureaucratic channels, it will soon become buried in red tape and and invite disbursement of funds into areas other than colonization.

The biggest boost space colonization could receive at this time would be to have Dr. Leary and Captain Freitag change jobs. Judging from the interviews (which are most interesting) Captain Freitag seems to look upon the whole adventure as a dubious risk. Dr. Leary, on the other hand, is the pioneering type of individual who would be best suited for the office of Advanced Programs at NASA.

Richard Semock
APO San Francisco

Personally, I like Jesco von Puttkamer's "push/pull" approach (L-5 News, *November, 1976, page 2) to space settlements. That is to say, we need both the radical visionaries to "pull" us toward their hopes of the future and the pragmatic and cautious people who look at where we are now and think about how to "push" ourselves into the future. How does this relate to Leary and Freitag trading jobs? Just imagine what would happen if NASA were populated by starry-eyed individualists? The non-starry-eyed taxpayers would be darn skeptical about any proposals coming out of NASA and in short order would pressure the President into firing those far-out people.*

On the other hand, if the idealists can get the Great American Taxpayers to back their projects, then those pragmatic "push" people at Advanced Programs will be able to push just as hard as the folks like Leary are pulling. How about giving the folks at NASA a hand? -Carolyn Henson

I was happy to see the essence of the concept of the Fourth Kingdom as the lead in your January 1977 "soft" issue of the *L-5 News.* The cover artwork by J. Nix was especially exciting to me. The art was appropriate with its dramatic symbolism, reinforcing what the words are trying to say. I am convinced the knowledge of this evolutionary imperative resides just below the surface of consciousness of nearly everyone in the human family. Symbolic artwork, such as you have featured, can help reach through all of the irrelevant clutter in our consciousness and bring a new awakening to many.

In your very fine review of O'Neill's *The High Frontier,* Carolyn, you resolved with a few swift strokes of the pen a possible philosophical problem in the L-5 Society. You referenced O'Neill's interests in terms of "within this century, life can begin spreading outward into the Galaxy." And I totally agree that if the Galaxy is our ultimate goal, we can go on constructively debating and carrying out the probable intermediate steps humanity will take before eventually leaving this solar system. The pathway out may include any or all of the following: colonies orbiting Earth, Moon, Sun or other planets; colonization of many of the planets and/or some moons of Jupiter; industrial and scientific space activities in orbit and/or on the Moon, etc. There is increasing evidence people were thinking of space travel thousands of years ago. They could not have imagined the myriad of mechanical devices and scientific approaches civilization had to practice with and perfect to finally come up with a capability to leave Earth's gravity.

William J. Sauber
Midland, Michigan

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Corresponding with Professor O'Neill before the 1975 Princeton Conference, I raised some of the same questions as does John Holt in *Skeptic* about the possible military risks of space research, industrialization, and habitation. The best source of information that I have found on the subject since then was a book, *War and Space* (Prentice Hall), by Robert Salkeld who also participated in the conference. Unfortunately, the book is now out of print, but it may still be found in some libraries.

While warfare is not a pleasant topic, the book was surprisingly reassuring in at least one sense: Mr. Salkeld points out that all fixed or low-orbiting weapons (such as Mr. Holt's speculative "death-ray" satellites) are vulnerable to counterattack. The only area of real invulnerability is deep space. (Just try to locate and intercept a cruise-missile-sized weapon somewhere out there among the asteroids.) If man's propensity for war cannot be contained, I'd just as soon it be satiated as far from Earth as possible. And from L-5.

So, yes, of course there are risks in space development. It would be foolish to deny it. But I'm now convinced that the potential benefits far outweigh any such risks. (Indeed, warfare on Earth will be just that much more likely to occur if we do not make use of the resources available in space.)

Philip M. Blackmarr
Los Angeles, California

The book War and Space *is available in xerographic form from the L-5 Society for $7. How about a new edition, Bob?*

Aristotle was not aware of the asteroid belt though he wrote quite a lot about persuasion. We are more than merely aware of the existence of the asteroids. We know that the asteroids and the Moon are reservoirs of mineral wealth-the stuff of which space colonies are built. Yet we must concern ourselves with the same elementary question that occupied Aristotle: What is the process by which one is moved to action? How is it that people are persuaded?

To realize the goal of the L-5 Society, that of disbanding in a mass meeting at L-5, a great many people will have to be moved to perform some very significant actions.

Unfortunately, the mere fact that it is technologically feasible to construct space colonies is not an argument that will sway the masses, and their leaders in government and business, to initiate a space colony construction project. For example, controlled fusion reactions are not presently technologically possible but are hotly pursued.

Something else controls the spigot; what is it? Modern persuasion theory generally holds that if an appeal does not touch a person's values it will be ineffective. Furthermore, appeals to personal values (e.g., self-preservation, personal freedom, financial well-being and self-esteem) are more likely to lead to action than are appeals to non-personal values such as "brotherhood" or "exploration and expansion." Among the personal values, the value which is affected most directly and most immediately will dominate. If all are equally threatened, self-preservation is far more powerful as a determinate of action than is financial well-being or self-esteem.

When the Soviets took the lead in the fictional "space race," many Americans perceived a direct threat to a plethora of values including self-preservation and self-esteem. Financial considerations became subordinate until we felt the threat had dissipated. Countries run deficit budgets and create inflationary conditions in order to appease threats to personal values posed by their neighbor's ICBMs, MiGs, and Phantoms.

How is it that an appeal or persuasive condition comes to affect a value hierarchy? It generally seems that if the facts supporting an appeal are believed, values will be affected. Thus appeals for birth control will not tinge self-preservation values and hence will go unheeded among those who don't believe the world is overpopulated or who don't believe overpopulation is the cause of resource scarcity.

Thus an ideally persuasive campaign must be backed by facts which are credible and verifiable. The speed with which the desired action will be implemented will largely be a function of how directly the audience perceives the appeal to affect salient personal values less how directly the appeal is perceived to affect contradictory values.

"Your money or your life?" If we think (s)he'll shoot, we'll usually pay.

Our biggest and broadest problem with space colonization is to make credible the claim that the presence of a burgeoning population and industrial establishment is a direct threat to the life and freedom of every citizen of the world. Unless people believe that an advanced industrial system operating on the skin of a planet immediately endangers their personal value hierarchy, few people will be convinced of the need to transplant people and industry to space. At the expense of sounding cynical about a man I very much regard, I doubt if Kennedy wanted Americans to go to space merely "because it's there." More likely is the explanation that we went because the Soviets were there. We believe something; that something affects salient personal values directly and immediately, and we act-quickly.

Another problem we have is that of generating widespread belief in space colonies as an attractive, practical and economical alternative habitat. Acceptance of this argument will affect all the values which motivate us to either stay where we are or move to a more attractive city, state or country (world?). Denial of this argument but acceptance of the overindustrialization argument would create a public policy which might incorporate ecological considerations but would not provide for space colonies as an "escape valve" in case policy did not work as planned-not an uncommon observation.

Accomplishment of these two persuasive tasks would likely result in rapid implementation of space colonization. A slower implementation could result from acceptance of the energy crisis as a serious personal dilemma and of solar satellite power stations as a practical alternative. Hopefully these power stations would be modern day "goldmines" or "crossroads" from which communities would spawn.

The grimmest scenario is one where nature does the convincing. When our planet pathologically convulses with overpopulation and overdevelopment it becomes problematic whether or not we could launch a space colonization project.

Dr. O'Neill and the L-5 Society are pursuing a rapid implementation path in demonstrating the economic viability and attractiveness of space colonization. Pursuing this path alone may eventually get us space colonies-though it may come after an immense amount of scarcity-induced human suffering. Patience may be a virtue, but in this context procrastination is a far more serious vice.

It is equally necessary for us to persuade people of the immediate nature of the survival crisis. Since any major project requires years of lead time, we must drive home the point that dangerous trends (e.g., scarcity and pollution) must be reacted to as if they were full-blown crisis situations. Despite the necessity of this line of argument for rapid implementation of space colonization, it is a path full of dangerous traps. Space colonization proponents hardly need to be further hampered by being dubbed "doomsday prophets." Such a persuasive campaign must be forceful yet subtle-a difficult condition to maintain. The structure of such a forceful/subtle campaign will need the input of many people and blossom after countless hours of thought. For our goal to be realized, such a campaign will have to be pursued on some sort of a significant level.

History from Aristotle's time to the present is replete with inane things that humans have been persuaded to do. I'm certain we all agree it is time we were persuaded to do something intelligent. L-5 is empty, the Moon is drowning in locked-in oxygen, and the asteroids are just waiting for a pick and shovel.

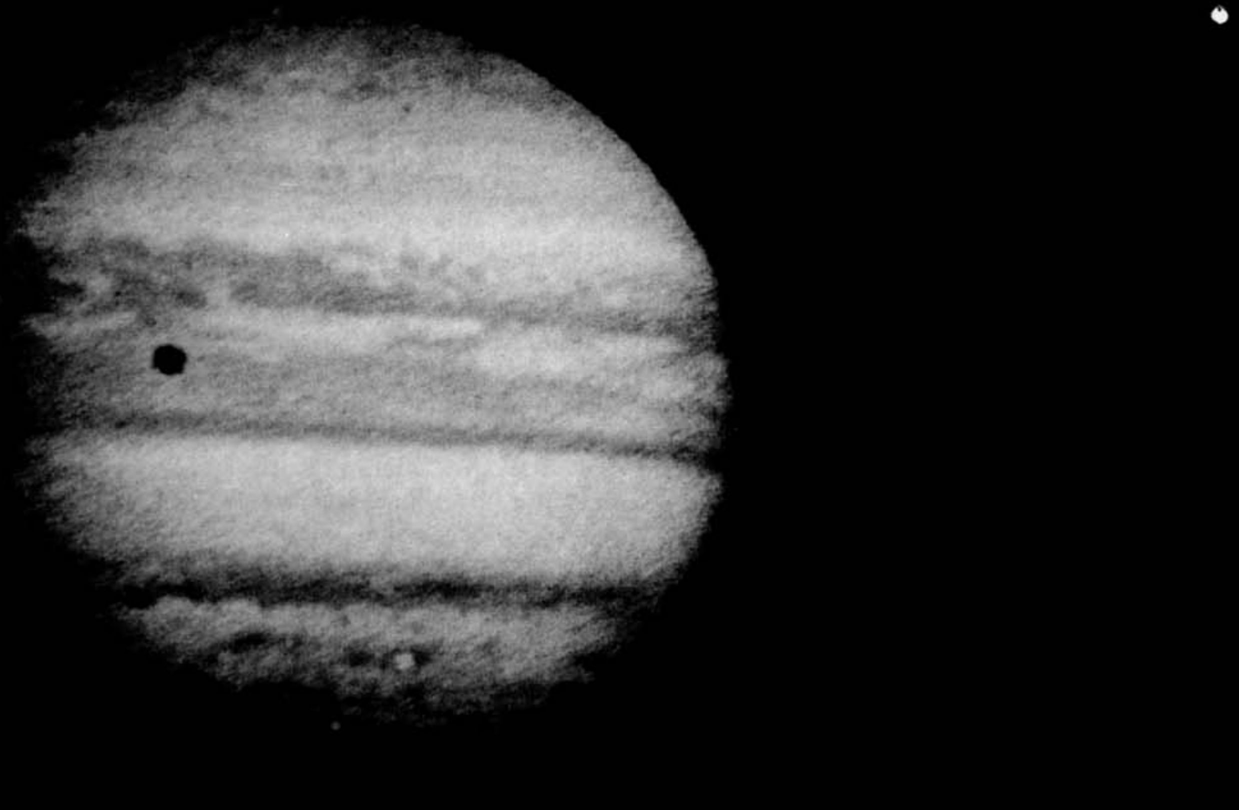
Martin Rothblatt
Los Angeles, California

L5 NEWS

AUGUST 1977 VOL. 2, NUMBER 8

IN THIS ISSUE:

HOUSE OK'S JOP
SPS, SPACE INDUSTRY FUNDS CUT



VIEW OF JUPITER AND ITS SATELLITE Io BY PIONEER 10

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HOUSE OK’S JOP

Washington, D.C.‘s July weather isn’t the only featureof the U.S. Capital that resembles a pressure cooker. Summer is also a season in which Congress puts the pressure on supporters of Federal programs to justify their funding requests.

Planetary scientists, elated at the unexpected inclusion of the Large Space Telescope in both the House and Senate NASA Appropriations Bills, were hopeful that the Jupiter Orbiter Probe (JOP) would also get the nod from Congress. JOP sailed through the Senate Commerce Committee and House Science and Technology committee, but the next step, approval by the House and Senate Appropriations Committees, looked less easy. Perennial NASA bogeyman Senator William Proxmire (D-Wis.) had made unfriendly noises about both the Large Space Telescope and JOP. But his committee allowed the two programs to stand, while, over in the House, supporters were caught off guard when Edward Boland (D-Mass.) nixed JOP.

Because the House and Senate versions of the NASA Appropriations Bill differed after Boland’s JOP deletion, a joint Senate/House conference committee was formed to iron out their differences before reporting the bill to the floors of the two chambers for a vote. (A yes vote from Congress on such committee-approved funds is virtually automatic.) But this time the committee reached an impass. Boland refused to back down on JOP, asserting that “NASA always gets what it wants,” while NASA’s Office of Congressional Liason complained that “We’ve hardly ever had a project come off on time in the last several years because they cut back our money and we end up having to juggle things around.”

Wednesday, July 13, the committee was hopelessly deadlocked. Near midnight, in a surprise move, Boland called for a vote of the full House on his JOP deletion move. The vote was scheduled a scant two days later: Friday, July 15.

JOP supporters were stunned. As a worried NASA official recalled, “I’ve been in Congressional Liason for at least 14 years, and a House Committee’s recommendation on a NASA appropriation has *never* been overturned on the floor.” And, as asteroid expert Clark Chapman was pointing out, “Only 35 or so out of the 435 members of the House have even heard of JOP.”

It looked like the end of an era. Planetary flight mission funding had been declining precipitously for years. The demise of JOP would have meant that the early development team at the Jet Propulsion Laboratory in Pasadena, which lays the foundations of all planetary missions, would be disbanded.

Planetary scientists are normally an apolitical lot. In the past, their projects were quietly snuffed out in committee. But the completely unexpected opportunity to battle it out on the House floor goaded them into action.

“We’ve got to take it to the people-the folks who are standing in line to see Star Wars,” declared San Diego scientist Jim Arnold. Thursday, with no more than 36 hours to go before the scheduled vote, the Division of Planetary Sciences of the American Astronomical Society sent telegrams to all planetary scientists.

Across the nation planetary scientists read their telegrams and grabbed the phone, calling the local news media and alerting friends. A long distance “telephone tree” was set up to reach as many people as possible. “If you call 7 people and tell them about JOP and get each of them to call another 7, and so on, we’ve got it made.”

Telegrams and phone calls began arriving at Congress; by Friday the phone at NASA’s office of Congressional Liason was ringing off the hook. “There were literally hundreds of House staffers calling,” a NASA official reported. “They’d say, ‘Hey, we’ve heard JOP is in trouble. What’s JOP?‘”

In the meantime, unexpectedly long House debates on other bills made it clear that the JOP vote would be delayed at least until Monday. Word flashed over the hastily organized phone network: “We’ve got a chance!”

Even so, time seemed hopelessly short. One Republican staffer who had first heard of JOP’s problems around midnight Thursday complained, “After spending all day going around to other Representative’s offices, when I went home Friday night I felt like beating my wife! Getting those people aware of what’s happening to JOP is like trying to nail jello to the wall.”

Monday morning Washington residents, as is their custom, read the Washington Post over breakfast. Inside they found an editorial supporting JOP. Over on Capital Hill, California governor Jerry Brown, Morris Udall (D-Arizona) and Carter Science Advisor Frank Press were using their not inconsiderable influence to woo Democratic votes for JOP. On the Republican side, Minority Leader John Rhodes and John Ashbrook (R-Ohio), among others, were also lining up votes for JOP. The political pros now were giving it a 50/50 chance.

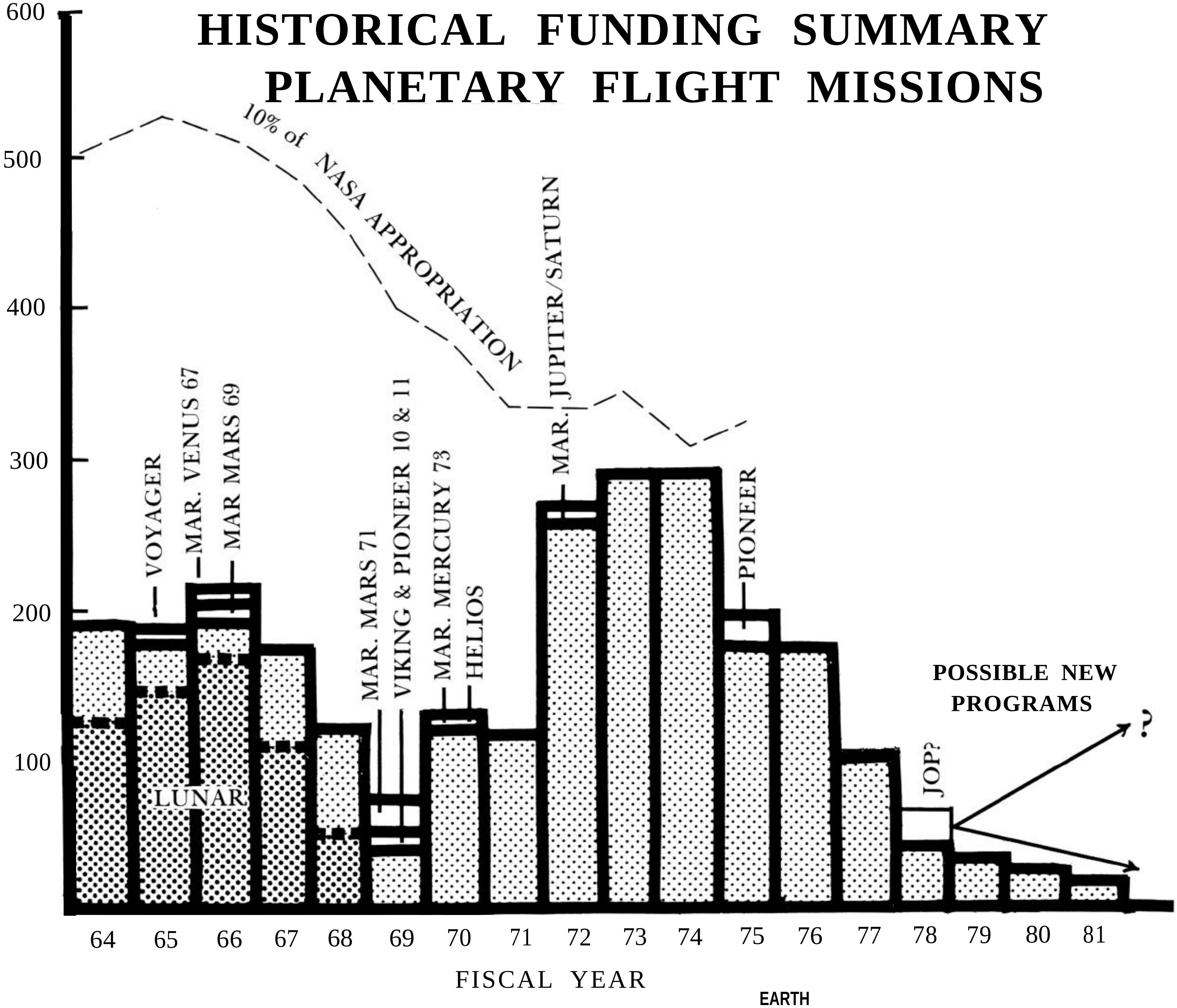
Tuesday, July 19, rolled in wet and hot. Inside the chamber of the House of Representatives the air conditioning was doing its job, but planetary scientists in the visitors’ gallery were sweating. JOP, given a reprieve until now, was about to be voted on.

The hour of scheduled debate opened with Edward P. Boland. He held the floor for nearly half an hour, defending his committee’s cut of JOP funds. Then JOP supporters got the floor. The first to speak was House Minority Leader John Rhodes (R-Arizona) (see related story). He was followed by Barbara Mikulski (D-Maryland), who wisecracked, “I hate to have to agree with the Minority Leader, but . . .” And one after another, some 30 Republicans and Democrates from all over the country got up behind the podium and defended JOP.

However, the real action was not on the floor, where only some 60 out of the 435 members of the House were present. JOP supporters were concerned about rumors that Speaker of the House and close Boland associate Tip O’Neill was out gathering votes to kill JOP.

(Continued page 4)

HISTORICAL FUNDING SUMMARY
PLANETARY FLIGHT MISSIONS



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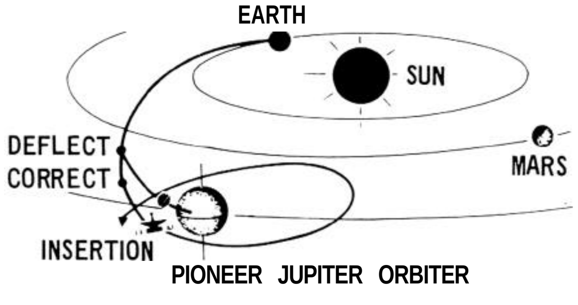


Probe release from the bus occurs at 500 Jupiter radii from the planet in a plane slightly tilted to the equatorial plane. The targeted entry point is 3.15 degrees North latitude and 28 degrees before the evening terminator. Entry is at -7.5 degrees at 450 kilometers (km) above Jupiter's theoretical one bar pressure level and at a relative velocity of 47.4 kilometers per second. When the probe senses deceleration, it initiates warmup and prepares to start its scientific measurements. After a peak deceleration of about 300 g's, the deceleration level drops off, and at about -3g's the probe will be in a subsonic flight condition. Sensors are then deployed, data is formatted, and real-time and stored data are interleaved onto the RF telemetry link to the spacecraft bus. The telemetry carrier wave is used for acquisition purposes and to provide range rate data by Doppler techniques, and for reconstruction of an atmospheric model of Jupiter.

RHODES LEADS SUCCESSFUL EFFORT TO PRESERVE JOP

Congressman and House Minority Leader John J. Rhodes (R-Ariz.) spearheaded a successful effort in the House of Representatives to preserve funds for the Jupiter Orbiter Probe despite attempts to abolish the program. After debate during which both Republican and Democratic members spoke in favor of the probe, the House voted to appropriate money for the program.

An amendment to the National Aeronautics and Space Administration appropriations bill sought to delete funding for the Jupiter Orbiter Probe Program for Fiscal Year 1978. After debate during which Rhodes led efforts to strike down the amendment, it was defeated 280 to 131.

In remarks from the House Floor, Rhodes told his colleagues, "I believe that deletion of the funds for this program would seriously set back our balanced space efforts."

"The Jupiter Probe provides the first in-depth opportunity for exploration of the planet's atmosphere and is expected to advance our knowledge of atmospheric processes," Rhodes said. "I hope that my colleagues would want to take advantage of this opportunity to maintain U.S. leadership in space exploration."

"In addition, the program is a key link in maintaining our leadership in planetary exploration and dedication to expanding knowledge of the universe. As had been pointed out by other Members (of the House of Representatives), the program is now designed to take advantage of the optimum launch date in 1982. The next optimum launch time will not come until 1987, and any interim effort would require a greater launch energy."

"Any delay in the funding of the program would not only delay our space efforts but would cause the disruption of this highly coordinated effort and could result in the loss of very specialized personnel," Rhodes said.

House Minority Leader John Rhodes

House OK's JOP *(Continued from page 2)*

At the end of the speeches a voice vote was called. Those who backed Boland's JOP cut called out "aye." Then the "nay's" rang out, far louder. But Boland, expecting that the absent Representatives would back him, called for a quorum.

A buzzer rang throughout the buildings of the House of Representatives. In offices, hearing rooms, corridors and cafeterias, the Representatives got the message: fifteen minutes to get to the floor and vote. The rush was on.

Those already on the floor filed over to the forty voting terminals. One by one they inserted their plastic identification cards and pushed a button to indicate a yes or no vote. An electronic scoreboard then flashed his or her name and vote, and talleyed up the score.

As expected, the early count from those who had given the voice vote ran 2 to 1 against Boland's measure. But they were only a small fraction of the total. Then the rest of the Representatives began crowding in. Hundreds of them. In the gallery, the scientist's eyes were riveted on the scoreboard as the votes piled up. The 2 to 1 margin was holding-Tip O'Neill had decided to remain on the sidelines, and Boland was on his own.

The timer counted down to the end of the fifteen minutes. The vote was in: 280 opposed the JOP cut, and only 131 supported it.

In the gallery, the scientists were jubilant. Across the nation the phone network went into action once again, carrying congratulations to the citizens who had joined hands in the JOP rescue operation.

Asteroid expert Clark Chapman, on behalf of the planetary sciences community, extends thanks to L-5 members, who with their money and action helped to save JOP. -Carolyn Henson

SPS, SPACE INDUSTRY FUNDS CUT

July 13 a House-Senate conference committee finalized all NASA appropriations except for JOP (see lead story this issue.) The Large Space Telescope was awarded $36 million, and the cut in Shuttle funds made by Rep. Boland's subcommittee was restored, with the proviso that certain program milestones should be met.

However, several NASA requests were cut. Among them were a $5 million reduction for space industrialization studies and a $2 million cut in solar power satellite funds (hey, folks, that's us!) Also cut was $3 million for Viking follow-on studies. A $2 million ozone depletion study was dropped entirely.

FROSH STEPS UP TO NASA POST

Dr. Robert A. Frosch, 49, has become Administrator of the National Aeronautics and Space Administration. Frosch was Associate Director for Applied Oceanography at the Woods Hole Oceanographic Institution on Cape Cod, Mass.

Frosch succeeds Dr. James C. Fletcher, who resigned May 1, after six years service as NASA's Administrator.

From 1973 to 1975, Frosch was Assistant Executive Director of the United Nations Environment Programme, holding the rank of Assistant Secretary General of the United Nations. Previously, from 1966 to 1973, he was Assistant Secretary of the Navy for Research and Development.

Frosch's professional career began in 1951 with the Hudson Laboratories of Columbia University, where he worked on Naval research projects. There he progressed from Research Scientist to Director of the Laboratories, becoming Director in 1956 and remaining in that post until 1963.

Frosch, a native New Yorker, earned his A.B., A.M. and Ph.D. degrees at Columbia University. He is a member of Phi Beta Kappa and Sigma Xi. He received the Arthur S. Flemming Award in 1966 and the Navy Distinguished Public Service Award in 1969. Frosch is a member of some nine scientific professional societies and the author of numerous scientific publications.

Dr. Robert A. Frosh

IT'S EYES DOWNWARD

by Leonard Dauid

On June 23rd NASA's fifth Administrator in its 19 year history met the Washington press corps at what was billed as a "get-acquainted" news conference.

New NASA Administrator Dr. Robert Frosch, in his opening remarks, sprinkled holy water on a wide variety of current and future NASA activities, but underscored his discussions with the attitude of "getting the NASA house in order." Demonstrating a "first things first" attitude, Frosch emphasized the need to complete the development of the Shuttle and prepare a foundation for even more elaborate applications of our space capabilities.

It is clear that the new NASA Administrator has a keen eye on applications programs and in increasing public awareness of NASA's entire stable of application satellite concepts. But with this increased capability, Frosch strongly feels that management of those systems is paramount. "As the Shuttle comes into being, we are going to be doing things in the application direction that are going to be entirely new in the way we put together systems and manage them. I think that is going to take a considerable major new effort," stated Frosch.

When questioned about the space settlement concept, Frosch reacted. by saying "I want to understand better than I do now why we want to colonize space and what it is that will be gained by doing that. In any case, I don't think we will understand how to do it and why until we have some experience with routine use of the Shuttle."

Continuing Frosch emphasized that, in the case of space settlements, "we have just begun to get our imaginations and our thoughts fired up. In every major technological development that I know of." said Frosch, "the import uses were not the ones that you were able to think about in advance, but the ones that came upon you when you actually had the tools."

According to Frosch, even near term space station development looks a little far off. Frosch believes that the technology isn't at hand to build a large permanent space station, or "even a long-term colony with a lot of people. I have not seen any reasons that have convinced me that *now* is the time to make a major attempt to do such a thing. I don't know when the time will be to do that," observed Frosch.

However, Frosch considers NASA as the "logical" agency to develop the Solar Power Satellite concept, with the space agency engaging in small-scale experiments to test the feasibility of an SSPS system via the Shuttle.

Summing up, it appears that Dr. Frosch has taken up T.V. star Leonard Nimoy's (alias Dr. Spock) quest of "In Search of . . ."

You advocates of large space stations, SSPS, space settlements, and possible resumption of expeditions to the moon and planets, will have to wait. It's eyes downward, and more earth-assisting satellite applications. Luckily the Universe will be patient!

SPS DISTANT, SAYS FROSH

A satellite solar-power system "appears to be technologically feasible," but its development and use are "between 25 and 100 years" away. Robert A. Frosch told a Senate committee in June hearings to confirm his nomination as head of the National Aeronautics and Space Administration. Supposing thermal energy were collected by large space-based solar-cell arrays, "we have only the sketchiest ideas of the costs" of converting that energy into electricity and transmitting it to earth for distribution by microwaves or other means, Frosch said.

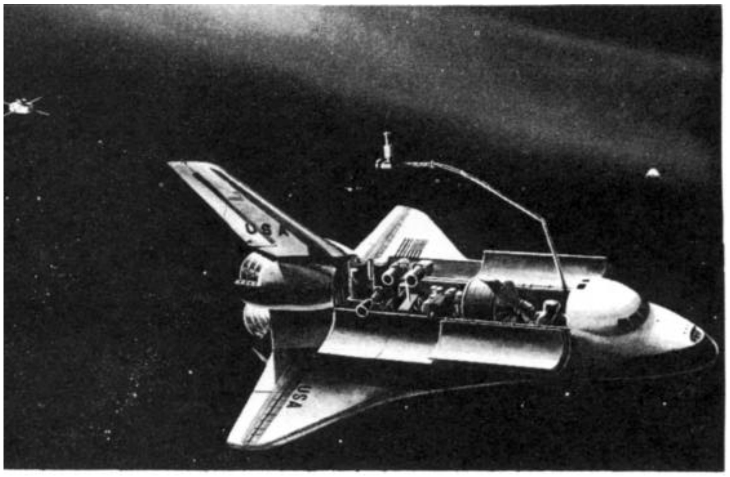
But NASA will get a better handle on satellite solar-power economics -- including the cost of erecting large space structures-when it begins using the Space Shuttle, Frosch believes. The transmission problem "will have to be attacked on its own merits," but only after "we have a better capability for the appropriate structures and experiments in space."

MILITARY SHUTTLE FLIGHTS PLANNED

When the space shuttle starts flying in 1979, the U.S. military will for the first time be in charge of piloted missions beyond the atmosphere. Current estimates are that one third of the projected 725 shuttle flights in the 80's will be under military sponsorship.

Plans are to use the shuttle for satellite deployment and repair. The military has also offered to develop a "space tug" for NASA which will boost payloads from the shuttle's 100-500 mile high orbit range to 20,000 miles and higher.

What do these plans mean for the space warfare debate? Mr. Currie, Director of Research and Development for the Department of Defense, says, "Over the next 10 or 15 years, space is not going to remain the unmolested territory, the sanctuary, that it is today. This issue must be addressed explicitly."



NEWS FROM ERDA

ERDA/NASA POWERSAT CONCORD

A series of meetings between NASA Deputy Administrator Alan Lovelace and acting ERDA Administrator Robert Fri has culminated in a joint NASA/ERDA solar power satellite (SPS) research program. The proposed SPS program calls for expenditures of a total of $19.5 million over the 4 years from 1977 through 1980.

It provides for an outlay in the current fiscal year (1977) of $2.5 million within NASA and $700,000 within ERDA. In fiscal year 1978 NASA is slated to spend $3.5 million and ERDA $2.6 million. This compares with the $4 million Congress has already approved for NASA SPS work in FY '78 and $3 million which is currently under consideration in a joint House/Senate conference committee for ERDA in FY '78.

The SPS energy program has been sent to energy czar Schlesinger where it awaits his approval and incorporation into Carter's energy plan. And while enthusiasts may complain that the SPS program is not yet a booming business, at least power satellites are gaining a place in the sun within the Carter administration.

ENERGY SOCIAL ISSUES STUDY

Researchers at Yale University will attempt to determine the social consequences of some of the Nation's key energy options under a new program funded by the Energy Research and Development Administration (ERDA).

The research will be carried out by Yale's Institution for Social and Policy Studies. It will involve a multi-disciplinary group of Yale faculty and ERDA scientists.

Professor Charles Walker and Dr. Leroy Could of the Institution will be in charge of the program. ERDA funding for the first year of the project is $155,000.

"There already has been a great deal of social science research done on certain types of energy development projects," said Dr. James A. Liver-man, ERDA's Assistant Administrator for Environment and Safety. "Unfortunately this research is duplicative and merely describes the problems. In this program, we intend to evaluate the existing social science research on energy so that our future efforts can provide more concrete approaches to solving some of the problems that have already been identified."

The team will examine the social consequences of energy options under development by ERDA, including such issues as employment, community growth, transportation, government regulation, and public participation in decision-making.

Initially, they will concentrate on the social consequences of increased use of coal and nuclear power, application of various conservation approaches, arid the use of solar energy.

The Yale team also will assist ERDA in identifying social science research issues which should receive increased attention in energy technology planning and development. This "Mapping Project on Energy and the Social Sciences" will also help ERDA to plan future social science research projects.

ERDA ISSUES NATIONAL ENERGY R & D PLAN

The Energy Research and Development Administration (ERDA) has issued its annual plan for research, development and demonstration efforts in support of the President's National Energy Plan.

Acting ERDA Administrator Robert W. Fri noted in a transmittal letter to Congress and the President that "the President's overall energy plan provides the neededcontext for the national energy RD&D effort and includes specific sections on energy RD&D."

Single copies may be obtained by writing to ERDA, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

BOOK REVIEWS

Colonies in Space

by T.A. Heppenheimer, Stackpole, 1977. Reviewed by K. Eric Drexler for AIAA Student Journal and the L-5 News.

Colonies and the future of humanity in space make a complex topic. To do it justice is difficult, but Dr. Heppenheimer's book has succeeded quite well, combining background information, dreams, graphics, and engineering numbers with lively writing to produce a pleasing package.

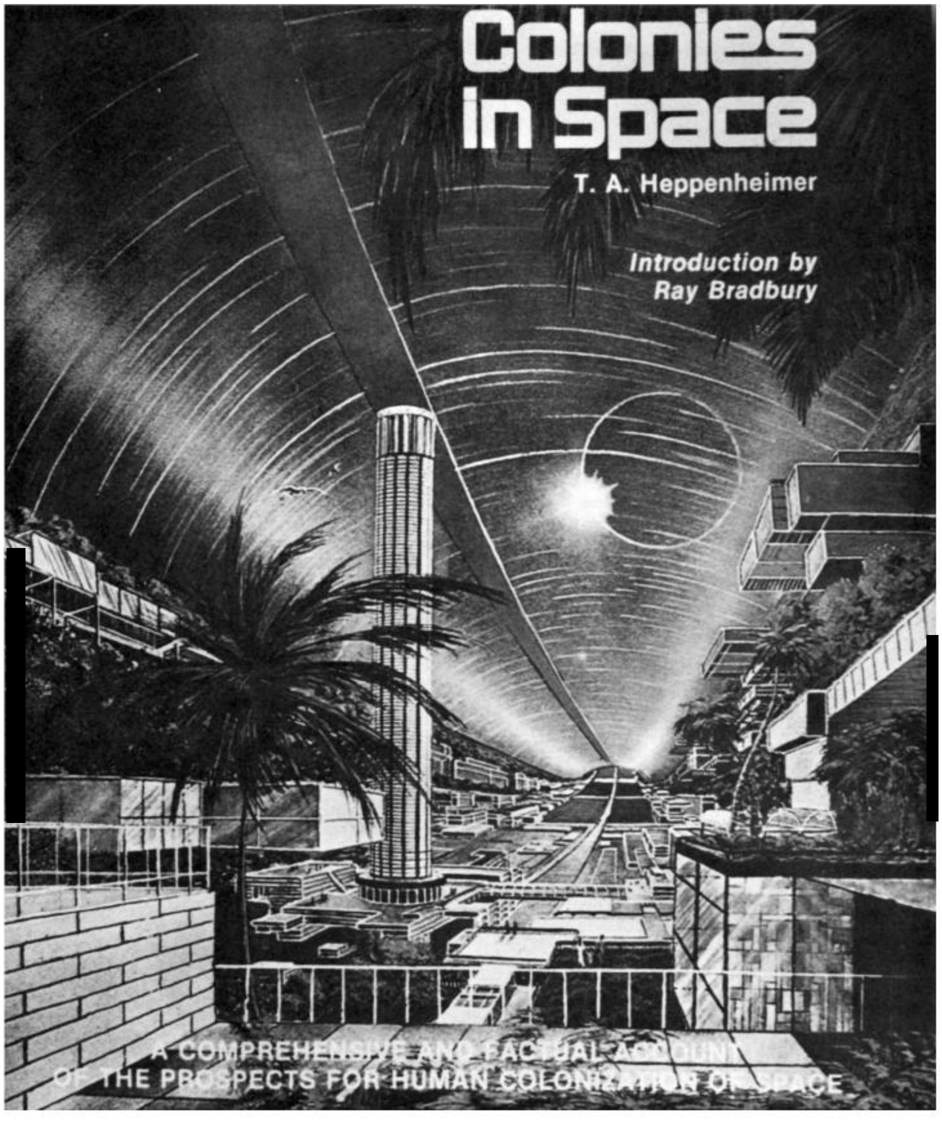
Topics discussed include the solar system as a place for life, the history of the space colony idea, power satellites, the potential impact of colonies and power satellites in the next several decades, the space shuttle and advanced lift vehicles, lunar resources and their exploitation, the mass driver, establishment of early industrial facilities in orbit, specific space colony design ideas, agriculture in space, construction of colonies research and industry in space, the potential of the asteroid belt for human settlement, and the eventual prospects for interstellar expansion. Heppenheimer builds on the solid base of his background as an aerospace engineer, planetary scientist, and participant in the major conferences and studies dealing with space colonization.

The concept of colonies as an integral part of large scale industrial activities in space has become gradually more influential. The early visions of mammoth "new Earths" in 2050 have gradually gained roots which twine comfortably with Shuttle-era programs of the 1980's. The early justification of exporting population to ease pressure on Earth a half century from now has given way to the idea of using non-terrestrial resources as a short-cut to economical power satellite construction in the 1990's. Changes of concept and mission continue today, but the underlying theme of a beach-head in space using non-terrestrial resources remains, and appears to be gaining strength under scrutiny.

Portraying such a shifting topic presents problems. Deciding what audience to write for presents further problems. In "The High Frontier," one of the other recent books on this topic, Dr. O'Neill writes to an audience that is humanistic, skeptical, and needs to be convinced of the practicality and relevance of space. His book, therefore, is cautious in tone and is careful to build a strong case for "why" before attacking "what," "how," and "what next?" It deals with the changing topic by concentrating on what are hoped to be solid general concepts, rather than on details of scenarios and systems. In "Colonies in Space," Dr. Heppenheimer writes to an audience assumed to be receptive but not necessarily enthusiastic. His book, therefore supplies the "why" and the "how" as it goes along, without exercising itself to prove at the outset that space is relevant and that living in space is not science fiction.

"Colonies in space" shows an unusual concern for both entertaining and informing the reader. The writing is clear and lively, sometimes crossing the line from exposition to drama. Ideas are not presented as results of science, but as results of individual's work and of earlier ideas. Background material (which pulls its own weight in reader interest) appears throughout the book. This ranges from a capsule description of the solar system (rather than simply alluding to "asteroids," etc. with which some readers will be unfamiliar) to a history of the political and economic factors that led to today's Space Shuttle.

As a book to lend a friend, "Colonies in Space" is an eye-catcher. Most pages are broken by diagrams, illustrations, photographs, or paintings (some reproduced in color). It is the sort of book whose title gets it picked up off the coffee table, whose graphics and layout earn it an interested thumbing-through, and whose text gets it read.


Colonies in Space
T. A. Heppenheimer
Introduction by
Ray Bradbury
A COMPREHENSIVE AND FACTUAL ACCOUNT
OF THE PROSPECTS FOR HUMAN COLONIZATION OF SPACE

PRINCETON CONFERENCE BOOK IN WORKS

Both those who made it there and those who didn't but wish they did will be pleased to learn that the proceedings of the 1977 Princeton Space Manufacturing Facilities Conference will be available in hard cover book form Oct. 1. Transcripts of the discussions which followed each paper are included, as well as the summary session in which MIT professor Rene Miller, Princeton professors James Arnold and Gerard O'Neill, the AIAA's Jerry Grey and Georgetown University Associate Dean Stephen Cheston pick out the highlights and heroes of the conference.

The '77 Conference wasn't just a nuts and bolts affair. Stephen Cheston reports that it was "especially valuable in highlighting key issues in orbital psychology and international affairs. The Conference was a major step in organizing a coherent body of knowledge in the social sciences which should run in parallel with space manufacturing facilities technical developments. Anyone interested in social science aspects should consult the conference proceedings book."

Those who want to receive the book can order it from:

Jerry Grey
AIAA
1290 Avenue of the Americas
NY, NY 10019

Grey projects the book's price at $8-12.

The papers reviewed below are from Grey's upcoming book on the '77 Princeton Conference.

"Vapor-Phase Fabrication of Massive Structures in Space"
H.K. Henson, K.E. Drexler

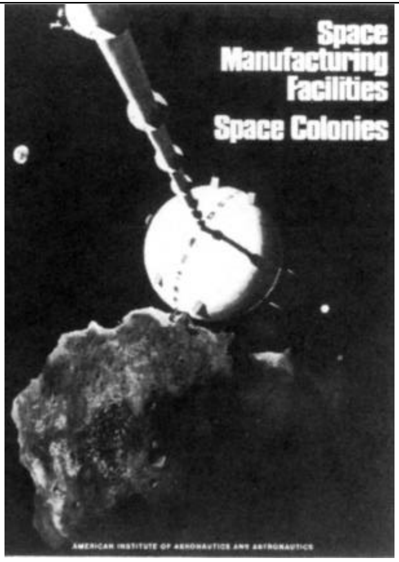
"Vapor deposition may be an economical approach to processing and fabricating metals (especially aluminum) in space. This method, which uses to advantage sunlight, vacuum, and zero gravity conditions of space, is found to have advantages when considered from metallurgical, physical and cost viewpoints. A design for a large scale (250 ton) solar powered deposition apparatus with a throughput rate of 10 kg/second and the associated physical and chemical material problems are described in detail." Using the described vapor fabrication system, "a plastic balloon of the proper size and shape would be inflated and metal deposited until the walls were strongenough to fill it with air and put up the real estate signs."

"Trajectory Dynamics In The Earth-Moon System"
T.A. Heppenheimer

"A comprehensive overview of the main features of the dynamical problems associated with transport of lunar mass to a space colony via a catcher near the L2 libration point. A theoretical treatment is given for achromatic trajectories (those for which the arrival point is insensitive to launch errors) . . ." "Catching strategies are considered, and equations are given for minimum-energy catcher maneuvering. The problem of optimal colony location is treated. . ." "It is concluded that a 2:l or 5:2 resonant orbit is preferable over alternatives of 3:l or 7:3 resonances, and is markedly superior to L-5."

SPACE MANUFACTURING FACILITIES (Space Colonies)

Here is the *first* definitive collection of *factual* studies and reports of space colonization written by top experts in the field.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Are you concerned about the energy shortage?
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Space Manufacturing Facilities (Space *Colonies)* is the first definitive collection of factual studies and reports of space colonization, written by top experts in the field. Space Manufacturing Facilities is not like other books where one author has worked alone on his theory---but it is a collection of technical papers, each one written by an expert in his own field.

This volume, the proceedings of the May 1975 Princeton/AIAA/NASA Conference on Space Manufacturing Facilities covers all bases:

- Space habitat construction, transportation. and costs.
- Commercial products, services, and the economics of trade with Earth.
- Human considerations -- physiology, psychology, sociology, politics, architecture, and law.
- Current government activities and plans.

Profusely illustrated with charts, tables, drawings, and photographs, this 322 page hardcover book is required reading for anyone seriously interested in space colonization and the future of the human race.

"Mass-Driver Reaction Engine as Shuttle Upper-Stage," Gerard K. O'Neill.

Describes an optimized design of a Mass Driver Reaction Engine (MDRE). It is designed to use Shuttle tankage as reaction mass to move payloads from low orbit to geosynchronous (or higher) orbit. It accelerates 14 gram reaction mass segments (which may be powdered for safety reasons) at 500 g's. The MDRE is found to reduce geosynchronous freight transport costs by approximately a factor of 3 and overall costs by a factor of 2. As a result "it appears that economic payoff does not require the development of space-farming." The program he outlines "appears highly profitable even if operated open-cycle." "Similarly, the development of large 'space colony' habitats does not appear to be a precondition for space manufacturing."

"Basic Coaxial Mass Driver Construction and Testing,"
Kevin Fine

This paper was written before the mass driver was operational; however, it was ready in time for the conference and . . . it worked! This design (described in the preceeding paper) was created during the fall and winter of 1976 by Profs. Henry Kolm and Gerard O'Neill. It was constructed by a student team at MIT.

"Assessment of Satellite Power Stations"
Robert A. Summers, H. Richard Blieden, Charles E. Bloomquist

"This paper reviews the [earth launched] SPS concept, summarizes the recommendations of the [ERDA] task group [on satellite power stations], and briefly discusses the joint ERDA-NASA program plan for future SPS activities." It is ominous to note that ERDA is going to "clearly identify barriers to SPS that suggest that all significant R&D investment in SPS be halted." This is earth launched SPS as compared to SMF SPS -- so if you should hear that SPS has been shown to be unviable, be sure to clearly distinguish between these two approaches!

VAJK WINS CONTEST

Joe Haldeman's contest (see May '77 L-5 News) to name his upcoming book on space settlements and industries (St. Martin's Press; illustrated by Analog cover artist Rich Sternback) was won by physicist J. Peter Vajk of Walnut Creek, California.

The title? *The Endless Horizon*

As Haldeman says, 'Classy, eh?"

Colonies in Space, Frederic Golden, Harcourt Brace Jovanovich, 1977.
by Conrad Schneiker

The worst thing I can say about this book is that its title is identical to that of T.A. Heppenheimer's recent book. So beware of this problem when ordering books.

This book is classified as juvenile literature and as such is excellent. It introduces Gerard K. O'Neill's approach to space colonization. The author, by his own admission, is something of a professional skeptic. As a result he has sidestepped the "gee whiz" trap without losing theexciting flavor of this venture. "My approach has been chronological. After the opening chapter's letter from the future, I go back in time to tell how O'Neill's proposal evolved and how he had been preceded by other farsighted writers and scientists. In the course of these reflections, I have also touched briefly on some of the high points of the United States space program, notably the extraordinary flight of Skylab-whose full significance as a landmark for living in space has yet to be fully appreciated by a now blase public. I next explain, step by step, how the first colonies might be built and what life on them might be like." This book is well written, well illustrated, and includes a useful glossary. Ideal for a young L-5er.

WHAT TO REMEMBER WHEN READING A STUDY REPORT

Much of the informative literature on spacecolonization is study writeups of group research. Just as the camel is a horse designed by a committee, so the group report is a paper written by several chimpanzees with malfunctioning typewriters, and suffers from lack of communication among its parts.

1) Responsible authorship tends to be inversely proportional to the number of authors, i.e., when there are ten to twenty authors, irresponsible statements tend to creep in such as "As X has said in the section on framistan maintenance," when in fact X never said that, wrote the portion on dingbat replacement, and has been arguing the opposite since the first time framistans were mentioned at the inception of the project. This happens because the final editing and rewriting is usually done at the last possible minute by one solitary group member with a hypertrophied sense of responsibility after the other group members have gone home to pass out in utter exhaustion. Their decision to let George do it ignores the fact that George too is close to terminal fatigue and is therefore unaware that he has erroneous and incomplete data. He writes what he thinks the others meant, but often it is neither what they actually did say nor what they meant to say.

2) Reading between the lines negatively is probably realistic; reading between the lines positively is usually unrealistic. This is because, given a confusing set of incomplete data, the solitary editor tends to make optimistic assumptions about the contents of missing pages, coffee-obliterated graphs, and vanished charts. Since Tom, Dick, and Harry decided to let George do it, they are not available to correct this unwarranted optimism and quite often would like to think the data did show that a reciprocating framistan would cut a minimum of six months off the time schedule while saving half a megabuck per unit. Sperber's Law should be kept in mind, "People tend to stretch the truth in an optimistic direction."

3) The results presented in the writeup are not necessarily arrived at during the study. In fact, any resemblance may well be coincidental. When the Horrid Realization that the final draft is due in two weeks finally penetrates the overburdened attention of the project manager, he says, "George, the results are this, that and the other-you might as well get started." George spends three or four days producing a masterful outline, an elegant opening statement, and a cogent closing paragraph. Then (surprise, surprise) he gets the hard data. At this point, he has the problem of a cat trying to bury something on a glass coffee table. The more he digs through the data, the more obvious it becomes that something is rotten. Reluctant to scrap the work done so far with a mere week to thedeadline, he takes the cosmetic approach.

4) Check the references. "Internal" references such as Private Company Memo No. 123 may be impossible to get and of dubious real value. A reference to something is not meant to be a way of ducking responsibility for doubtful data, but rather a guide for further in-depth study. However, in a moment of cosmetic despair, George may well decide to prepare Internal Memo No. 3.1416 and hide inconvenient data in it (beware of irrationally numbered footnotes), hoping no one will ask. Entirely too often, it works.

Many studies are produced by conscientious, well-rested Georges given considerable time and assistance by their colleagues. However, it many cases, the writeup is seen as the least important part of the project and gets only the scraps of time, energy and ability left after the Real Work At Hand has been completed. A word to the wise is scrutinized.

GOOD NIGHT, GEORGE.

(Written by a study team which wishes to remain anonymous)

CONFERENCES

THE INDUSTRIALIZATION OF SPACE

Fees for "The Industrialization of Space," the 23rd annual Meeting of the American Astronautical Society, are as follows:

	Member	Non Member	Student
3 days incl. banquet	$50	70	20
3 days w/o banquet	40	60	10
Per day	20	25	5
Banquet only	15	15	10

The only anticipated change would come in the banquet fee, if there is a "big name" speaker who charged a large speaker's fee. This would likely drive all the prices up by $5 or so.

"Member" includes members of any sponsoring organization, of which L-5 Society is one. (So hang on to your membership card!)

The conference is to be held Oct. 18, 19 and 20 in San Francisco. For further information, contact Paul Siegler, 415/969-0785, P.O. Box 7205, Menlo Park, CA 94025.

28TH INTERNATIONAL ASTRONAUTICAL CONGRESS

The 28th IAF Congress is to be held in Czechoslovakia this year and members are reminded that it will be held at the Hotel International, Prague 6, Czechoslovakia from the 26th September to 1st October 1977. The congress is being organised for the International Astronautical Federation (IAF) by the Organising Committee under the leadership of Professor Rudolf Pesek (Chairman, Czechoslovak Commission on Astronautics). Full details of the Congress can be obtained by writing to the IAF Secretariat, 250 Rue Saint Jacques, 75005 Paris, France. The theme of the Congress will be "Using Space, Today and Tomorrow." Brief details can be obtained from the L-5 WE Branch Director, Phill Parker, at 40 Lamb St., Kidsgrove, Stoke-on-Trent, ST7 4AL, United Kingdom.

SATELLITE FUSION POWER ?

On June 23-24 the Fusion Energy Foundation sponsored a conference at the Conrad Hilton Hotel in Chicago. It focused on plasma physics as a solution to the energy crisis. The conference was attended by about 40 people, mostly from the Chicago area and the surrounding Midwest region.

In the session devoted to the frontiers of science and technology Vid Beldavs of Cummins Engine Company proposed that fusion reactors be placed in geosynchronous orbit as proposed by Krafft Ehricke for nuclear reactors, explaining that this would reduce the need for vacuum pumps, ensure alignment and stability of magnetic fields and reduce construction cost in general.

WORLD FUTURE SOCIETY CONFERENCE

In keeping with general policy guidelines set forth at the first Southeastern Regional Conference of the World Future Society in Atlanta, Georgia, November, 1976, the Huntsville Chapter plans to host a regional conference in Huntsville, Alabama January 27-29, 1978. This conference will be a major part of a city-wide celebration of the 20th anniversary of the launching of the United State's first satellite, Explorer I.

The conference will feature speakers from major governmental and private organizations relating to the applications of space technology to human problems. The conference will also emphasize future directions in space technology.

All interested parties are encouraged to submit topics for discussion at the conference. The limited number of panels at the conference will have participants presenting papers, but because of the small number of sessions, these papers will be by invitation only. We are, however, arranging for a number of two-hour round-table discussions. If you are interested in organizing and leading such a discussion group, please let us know. Discussion leaders would be responsible for identifying and informing conference personnel of parties that might be interested in participating in the session.

Listed below you will see a number of suggested space-related topics for possible discussion. The topic you choose to present, however, does not have to be space-related. We encourage you to suggest discussion topics on any subject of general interest to the futurist community.

Energy from space
Biomedical research in space
Communications satellites
History of space activities
Materials processing in space
The future of space industrialization
Large-scale space habitation
  (L-5 type space colonies)
Sociological impacts of space technology
Environmental monitoring from space
Space-based astronomy
Space and the limits-to-growth hypothesis
The search for extraterrestrial life
Space and national defense
Global education through satellites
Philosophical and theological implications of expanded
  awareness from space exploration

All those wishing to organize discussion groups should let their interest be known by August 31, 1977. Please direct all correspondence to:

Dr. Donald E. Tarter
Department of Sociology
The University of Alabama in Huntsville
Huntsville, AL 35807

TOM HEPPENHEIMER VIEWS THE PRINCETON CONFERENCE

T.A. Heppenheimer

I was asked by Carolyn Henson to write down my impressions of the May 1977 Princeton Conference; that is, to be somewhat like Norman Mailer in drag. So this will not be a true and correct historical account of those four days. But it may *give* something of their flavor.

At the Princeton Conference, except for an unusual May snow flurry one noontime, the days were warm and clear. The campus was sunny and green, and the walkways were full of young girls on their bicycles.

My overwhelming impression was one of ceaseless activity, long night sessions with colleagues, and fascinating conference sessions by day-punctuated with occasional cheers from the conference hall lobby as the MIT Demonstration Mass-Driver once again worked. It was all very intense. In particular, it was a poor place to meet girls.

At the Conference, Gerry O'Neill was once again the genial host, the respected chairman, the master of ceremonies. The most impressvie single individual there, if indeed one may be singled out, was usually found engaged in adjustments to his beloved mass-driver. This was Henry Kolm of MIT. He radiated friendliness, openness, competence; these all were as obviously a part of him as were the pens in his shirt pocket.

He had accomplished the remarkable feat, in three months and for only $2,000, of leading a student group at MIT which had built a working model of a mass-driver. They had finished it only the day before the conference, then trucked it down by U-Haul. It was not in its full-blown lunar glory, of course; that would have been too much. But it did accelerate payload carriers, in single-shot demonstrations, at up to 33 g's. (O'Neill's 1974 *Physics Today* article had proposed that the lunar mass-driver, in its best performance, would give 29 g's.) Naturally, such tests were over very quickly, which made the coffee breaks ideal for the demonstrations. Following the announcement of an impending test, crowds would gather in the lobby while Kolm and his associates prepared for the test. Then the countdown, "three, two, one;" a spark, a report-and the payload carrier would suddenly appear at the far end of the track, where it had not been previously. After several days of this, one speaker, remembering the doubts as to whether mass-drivers could be made to work, noted ironically that the last announcement had been "as usual, the mass-driver will be demonstrated during the coffee break."

Several of the presented papers were taken from the 1976 Summer Study at Ames, or from follow-on work. Among these were papers by Frank Chilton and Gerry Driggers on chemical processing of lunar material-the processing equipment was packaged into a structure of Drigger's favorite diameter, 15 meters. I had the particular pleasure of reporting new work on the dynamical problems of lunar material transfer, giving results which the AIAA's Jerry Grey later described as "elegant." There were new and encouraging economic results from Mark Hopkins, as well as results on space construction by vapor-phase deposition, from Keith Henson and from the redoubtable Eric Drexler. Eric Drexler.

At that Conference, O'Neill and O'Leary spoke of such novel concepts as massdriver tugs and of asteroidal retrieval. O'Neill had fitted a low-thrust trajectory integration program into the 49 registers of an HP-25 hand-held calculator. With typical transfer times of some 150 days, the program ran in something like 0.01 of real time. But Henry Kolm was impatient, and wanted a bigger computer, so he was very happy when he got his wish -- an HP-67.

Available at the conference-at last-were copies of the 1975 Summer Study report, NASA SP-413. Enough of that Study's participants were there to make it worthwhile for all to exchange signatures, so that their copies soon resembled high school yearbooks.

Not all the news was cheery. In the midst of the sessions, we were told that a House Appropriations subcommittee had cut out funding for Lunar Polar Orbiter. And while they were at it, they'd also cut Jupiter Orbiter Probe.

For all this, there was on straw in the wind which went unremarked. A few years ago, aerospace professionals were attacked as "irrelevant," urged to "retrain" for work in urban housing, or transportation. Indeed, in those days Henry Kolm was working on novel forms of high-speed ground transport. But now he is working on . . .mass-drivers. And where he has led, others may follow.

T.A. Heppenheimer is the author of "Colonies in Space," Stackpole Books, 1977 (available from the L-5 Society).

Colorful Personalities

by Magoroh Maruyama

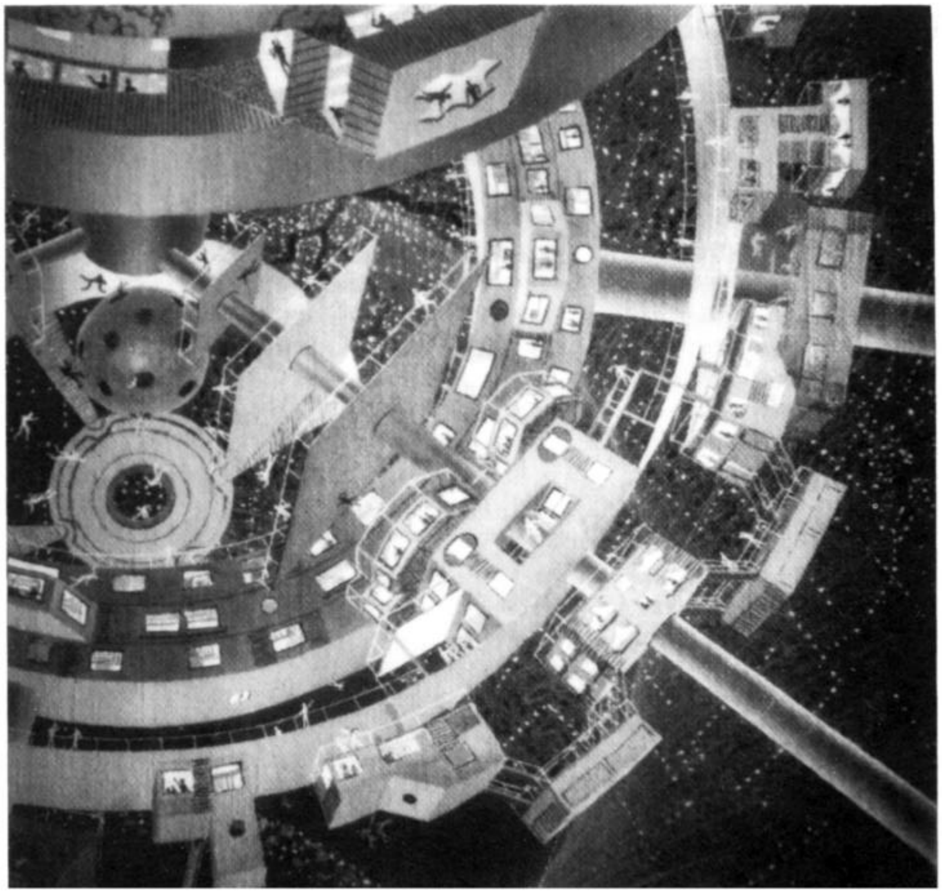
As members of L-5 Society get to know one another at various conferences and meetings, it has become clear that L-5 Society has a colorful assortment of different personalities. It is an eye-opening experience to meet them, stimulating and thought-provoking:

Carolyn Henson. This CH compound is a very sweet sugar, and as carbohydrate can be found in many other forms of organic materials. It has a property of dissolving and absorbing other chemicals. But as CMH -- Carolyn Meinel Hensen which she insists to be sometimes -- it is inorganic and is only an airline code for Columbus, Ohio.

Tom Heppenheimer is unforgettable for his very unique personality. If his uniqueness is used as a unit of measurement called "hep," ordinary persons would range in the micro-micro hep regions.

Magoroh Maruyama. When asked what he is, he says he is a Rorschach inkblot; different people see different structures in him. In any case, in terms of "mag" as a unit of measurement, most people are found in the meg-mag region.

Inside the L-5 Society



Inside L-5: the recreational area of a Bernal Sphere space habitat. (Courtesy Don Davis)

LOCAL CHAPTERS

What's there to do in a local L-5 group?

The Northwest L-5 Society, for example, is producing a monthly newsletter. Following are some choice excerpts from the June '77 newsletter:

EVERETT MALL ENERGY FAIR

The Northwest L-5 Society will have a continuous presentation during the fair for informing the public about space colonies. Coordinator for this exhibition is Bill Hadley, phone 363-0911. Bill is embarking on his fledgling journey as an L-5 lecturer, and so will welcome any help that members and friends want to offer

Vancouver, B.C., July l-4, 1977: The panel on space colonies at the Western Regional Science Fiction Convention, Westercon 30, will include famous science fiction authors Larry Niven and Jerry Pournelle, and possibly Frank Herbert, in addition to NWL-5 Society president Greg Bennett (eek!).

What does it take to get things rolling? For tidbits of advice, try writing Northwest L-5 president (and Boeing aerospace engineer in his copious free time) Greg Bennett, at:

The Northwest L-5 Society
13001 79th Place NE
Kirkland, WA 98033

INSIDE THE OFFICE

Volunteers over the last 6 weeks included Deborah Slavin and Trip Lazarus of Austin, Texas; Stella Calvert of Ann Arbor, Michigan; Jim Parker of Covina, California, and Tucsonans Danny Lee, Conrad Schneiker, Dennis Riggin, Rob Loss, Jim Anderson, the Yakowitz family, Maureen Hazlett, Benita Ebach, Kelly McLear, Windy and Gale Henson, Michael Thomas, Eileen Nunn, Mara Anzuini, and Elizabeth Martin.

The L-5 Society is under new management. Along with the change in management has come a change in our administrative office location. We are just 2 doors over, 1060 E. Elm, from the old office-and just down the block from our trusty mail address, 1620 N. Park. The Elm St. office is open 8 AM to 5 PM weekdays, and often someone is available at other times, also, to help you. Visitors are encouraged to spend time in the L-5 reading room, where an enormous volume of books, papers and the famed L-5 correspondence files are open to all. However, you should be warned that people who wander in off the street are in danger of being conscripted into the volunteer labor gang.

If you have ordered anything from the Society over five weeks ago and it hasn't arrived yet, or if you have missed an issue of the L-5 News (you should receive one every month) or have failed to receive a membership card, please write and tell us your problem.

One of the major ways you can miss the L-5 News is when you change your address. If the News goes to your old address, the Post Office cuts your old address out of the magazine, puts your new address on the scrap, mails it to us, (charging us 25¢) and throws away the News.

Need something in a hurry? Shipping Hot Line, 602-622-6351 is a red telephone by a big chalk board where rush orders are recorded, there to glower at us until dumped in the mail. Doris Cooper, the Hot Line Lady, is available from 8 to 5; in emergencies, Carolyn Henson, the intrepid L-5 editor, can usually help you out evenings and weekends either at the Hot Line or at home, 602-622-8520.

IRS report time is rolling around once again. By mid Sept. we need reports from the treasurers of all L-5 chapters in the United States on expenditures during the fiscal year ending June 30, 1977.

Chapters which demonstrate that they are alive and kicking by sending in the treasurer's report will receive an L-5 care package from headquarters. Con tents are: several dozen L-5 buttons, brochures describing the Society, Bernal Sphere posters to use in displays, and a copy of the L-5 bylaws.

TO LOBBY OR NOT TO LOBBY?

A recent issue of Astronautics and Aeronautics *announced that President Carter is opposed to any new initiatives, including the Lunar Polar Orbiter, Mariner Jupiter-Saturn, Jupiter Orbiter and atmospheric probe, and others. He is presently favoring such marketable items as communications and land use satellites. I have written to both President Carter and various members of Congress about this and other relevant topics, with little success. Perhaps a nationwide letter-writing campaign could influence matters (such as restoration of SSPS funding, etc.) Remember, Carter said many times that he wants input from "the people."*

Richard Schultz
Little Falls, New Jersey

The LPO has direct application to space habitats, it might find badly needed water at the lunar poles. With the JOP success, NASA might try for the LPO next year.--K.H.

In recent months quite a few people have written in about lobbying. What is lobbying? It is to work to get a specific bill passed by a legislative body. This should be distinguished from providing information. When the government requests input, such as inviting people and organizations to testify at hearings, or in cases such as energy czar Schlesinger's request for citizen input this spring, those who respond are not lobbying. But when offering unsolicited advice on legislation, or in urging others to offer this advice ("Write your Congressperson today about the dread Framistan Bill!") one becomes a lobbyist.

The L-5 News has at times wandered close to that fuzzy borderline between providing information and lobbying. The News has never urged readers to write their Congressional delegations. However, oblique statements such as "Our Wisconsin readers are reminded that Senator Proxmire is from your state" come darn close.

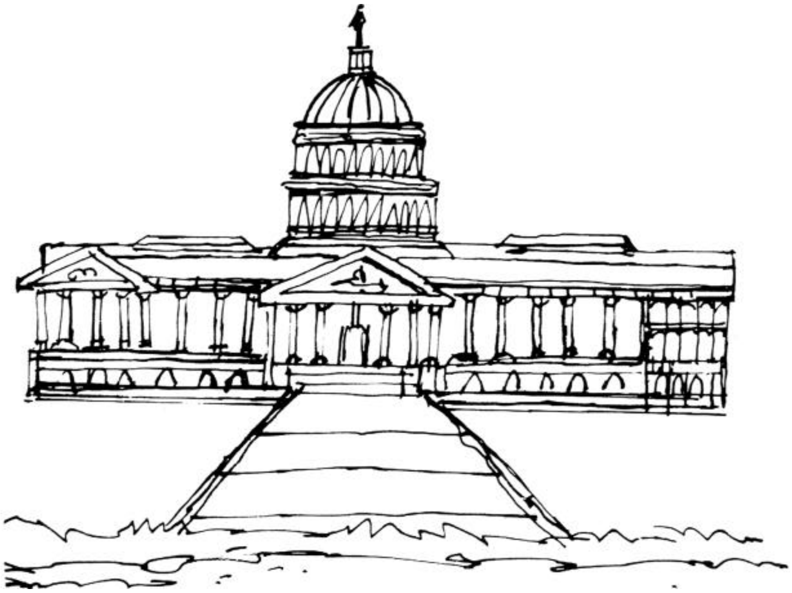
New legislation has made it possible for tax exempt organizations such as L-5 to spend up to 20% of their income on lobbying. But our newly gained freedom could be a mixed blessing.

First, if we choose to lobby, we must take sides. What happens to members who may disagree with the policy of the L-5 Board of Directors? Should the Society have the power to spend their money to lobby for bills they may oppose?

Second, lobbying requires a great deal of skill. A clumsy job can alienate potential supporters-look at the press South Korea is getting lately!

However, many L-5 members have personally engaged in lobbying, representing only themselves, rather than as spokespeople for the Society. They read the news and move into action. And they get mostly good results. Why?

One of Morris Udall's staffers tells us that most folks in Congress are leary of organized pressure groups. "If we get in a hundred letters in one week that all read the same we discount them," he says, but adds that "It's when we get a steady input of individual views that we know our constituents really care about something."



Following is a letter written by an L-5 member to Senator Proxmire. It is an eloquent, effective example of a citizen's lobbying. But if 100 form letters had been mailed instead, perhaps Proxmire's subcommittee, dismissing them as the work of cranks, might have given JOP the thumbs down and this month's cover story would never have been written.

Dear Mr. Proxmire:

As Chairman of the Senate Appropriations Committee, the 1978 budget of the National Aeronautical and Space Administration will soon be before you.

NASA is funded at a pitiably low level. I would accept a tax increase if it meant that the proceeds were going to our most productive and cost-effective agency. Technology is the only real product America has to sell, and NASA's positive record in medical, communications, and consumer spin-offs make it the best investment in town. With Federal and State governments soaking up virtually all venture capital in the United States, our Scientists and Engineers are entitled to Federal support of their research efforts. Space research is an investment in tomorrow, which we owe our children, since we have mortgaged them up to their trusting blue eyeballs to pay for our social comforts today. I would like to hope I could leave my children a legacy of hope, not of a stripped world and broken promises.

Specifically, I am concerned over public statements you have made against the Space Shuttle and the Space Telescope projects. In tandem with Representative Boland, you are in a position to do considerable harm to the lean and efficient industry/government space flight team. The investigation and ultimate mastery of Space is our opportunity to replenish earth's resources, and gather unlimited energy to feed and house the hungry of the world. Let us be the leaders in this noble cause. Let us be proud again.

"Give me a fish, and I eat for a day --
Teach me to fish, and I eat for a lifetime."

Thank you,
Ralph E. Evans
Mequon, Wisconsin

Letters

There seems to me to be a lack of something thus far in the activities espousing and facilitating L-5 inhabitation, orbital industry and all outer space endeavors.

What I'm trying to say is that the inevitable human conflicts of space exploration are not being as adequately foreseen and dealt with deliberately and intelligently as are the concrete technological problems and implications.

Observe the largely undeveloped equatorial nations' bid for their outer space "natural resource": controlling rights to equatorial geosynchronous orbits. Do I smell the beastie who would say to them: "It ain't yours if you can't get to it!" or "Try and stop me, sucker! "

Really, had no one foreseen such a confrontation? And what will be done in the UN to deal with it? Are we to be subjected again to the hideous continuing spectacle of arrogant ravaging (outer space) imperialism?

Joan Woods
Chicago, Illinois

You are a keen predictor of human reactions-see the next letter.--K.H.

On *the topic* of the equatorial nations claiming orbit space above their countries; sell them power at reduced rates or ignore them since they lack the equipment and expertise to do anything about it, equip SPS with short range defensive lasers.

Michael C. Strong
Swartz Creek, Michigan

Many people writing in the *L-5 News* have stated that the move from Earth to space is an evolutionary one. To this I can only recoil in horror. The characteristics of evolution are that it takes tremendous amounts of time, is conducted by a trial and error process, and is beset by an innumerable number of failures. If the movement from Europe to the New World had been an evolutionary process, Jamestown might just have been founded, with the Plymouth Colony a prospect for the early 21st century.

Space Industrialization and Habitation, clearly, cannot afford to be trial and error. An adaptation of one of Robert Freitag's recent statements could be that if we had killed the first and second man in orbit, this might be the Continental Shelf Society. That the move to space will occur I have no doubt, but I fear it will come too late for many of us around today. The best thing that could happen would be for the Saudi Arabians to announce they were contracting to build satellite solar power stations.

John Sotos
Hanover, New Hampshire

Where do we sign up for Arabic lessons?--K.H.

Capital! Capital! I refer of course to the May issue.

In seeking to define a suitable international regime for space colonization, it is useful to address the specific interest of the nations involved, and to consider analogies in current practice.

Thus, it is not necessary that the colony inhabitants be of diverse nations, or that the lunar workers resemble the crew of a Liberian-registry freighter. But the world's nations will be strongly interested in internationally-enforceable assurances that the power satellites will be available at predictable and controlled rates, and for as long as is required.

A similar situation exists in international aviation. Outside the Soviet Union, most aircraft are bought from Boeing or McDonnell Douglas or Lockheed. Yet it is in no way regarded as necessary that these companies' facilities be internationally owned or controlled, or that the work forces be multinational in origin.

On the other hand, international fares, and other conditions of operation, are under the control of agencies such as IATA (the International Air Transport Association), and are subject to such treaties as the Bermuda Convention and the Chicago Convention.

Similarly, one can envision an international rate-making body, akin to Intelsat, which would determine the fees and conditions for use of power satellites, in the export market. The U.S. would be a party to this, though the influence of other nations might result in rates and regulations which the U.S. would regard as unfavorable. Even so, there would still be the domestic U.S. market for powersats, which would not be under international regulation any more than our domestic airlines are under IATA.

Tom Heppenheimer
Heidelburg, Germany

As a geology student, I would like to comment on Joe Haldeman's letter in the April, 1977 issue. Carbonaceous chondrites are extremely fragile meteorites, and as such are very rate on the earth because re-entry heating easily destroys them. Impact on the moon is much more violent, due to the large terminal velocity (30 to 40 meters per second vs. roughly 5 m/s at earth surface). Impact at such speeds creates a crater 100 to 200 times the diameter of the meteorite, which is vaporized. The carbon implanted in this manner is extremely diluted and largely irretrievable in large quantities.

Richard Schultz
Little Falls, New Jersey

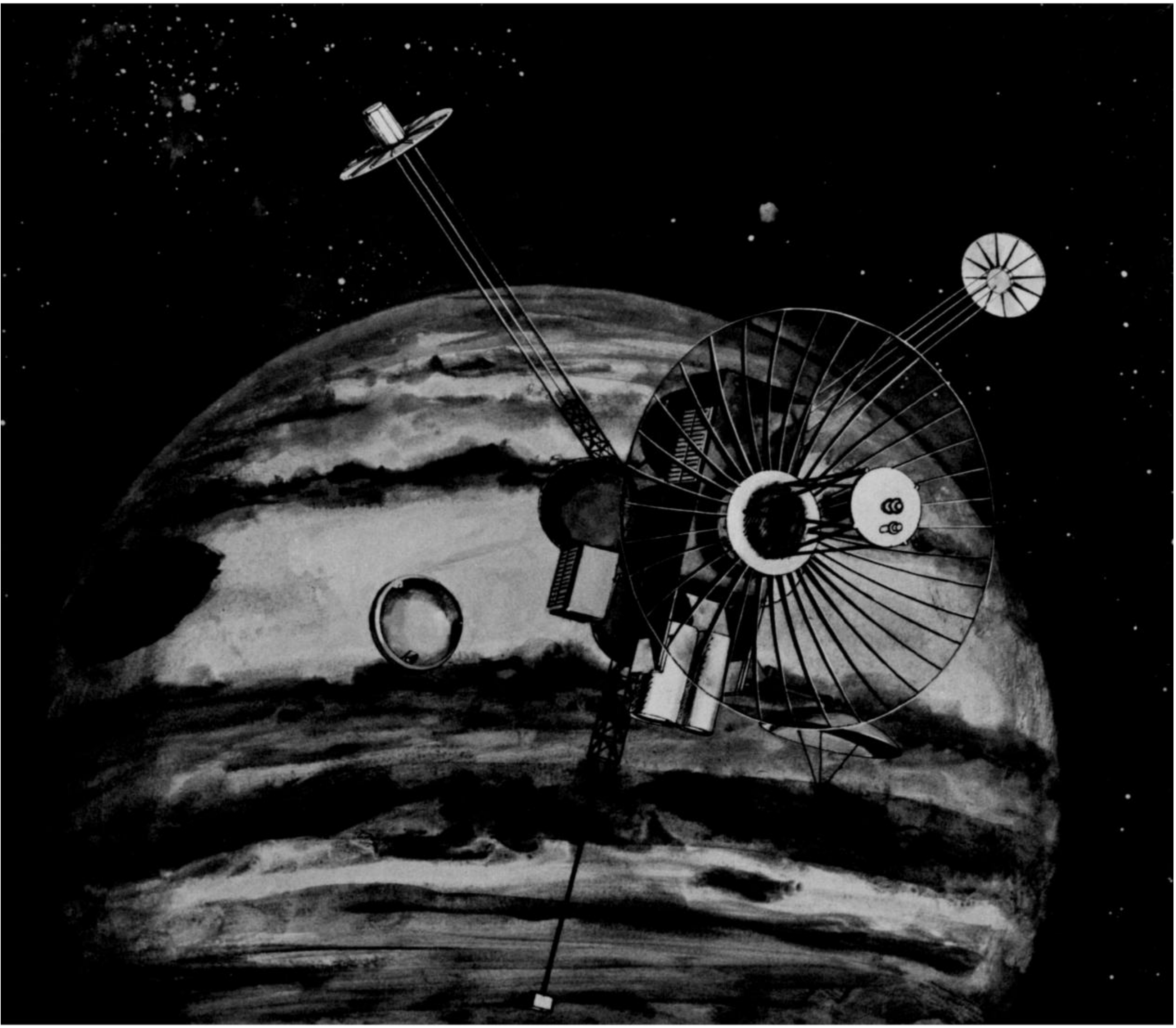
I am getting pretty sick of how our modem education is treating our science books, by not being very up to date but 5 years behind our times.

In my 6th grade science books they think that colonizing the moon is good but the people need laws there forcing them to exercise! (far-fetched isn't it!!)

The Libraries of America need some updating too! The one in Petoskey says that buying T.A. Heppenheimer's book is too costly, and that getting O'Neill's book isn't.

But the only thing I got our class and I to realize about colonizing space is building a model of a colony, the cylinder type! It measured "4" inches by "20" inches, "16" inches in place, and every inch represents a mile! It was named L-5, Island Three, Alpha O'Neill.

Troy Frantz
Petoskey, Michigan



HEADING FOR JUPITER -- The probe portion of the Jupiter Orbiter Probe spacecraft is launched toward Jupiter in this painting of a highlight of the planned flight. In the mission proposed by Galtech's Jet Propulsion Laboratory, a combination orbiter-probe spacecraft would be launched to Jupiter in January 1982. Flight time would be 1,000 days. Fifty-six days before reaching Jupiter, the orbiter would release the probe so that it would enter the planet's atmosphere on the sunlit side, taking measurements of Jupiter's atmosphere during the SO-minute-long descent. The orbiter would then go on to circle Jupiter for at least 20 months, studying the planet, its largest satellites, and the entire Jovian environment.

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In this issue:

2 **We're Going** *George Koopman reports on two milestones: the first Shuttle free flight, and Governor Brown's Space Day celebration.*

5 **Shuttle Milestones** *A report on progress with the Space Shuttle.*

8 **'77 NASA Summer Study** *A study team finds that an Apollo scale effort can bring solar power satellites, space cities on line by 1990.*

9 **More on Space Freeport** *Mark Frazier reports progress on a project to develop an international space port.*

10 **Space Spider** *NASA studies a new method to construct solar power satellites.*

11 **Inside the L-5 Society**

13 **Bibliography Update**

16 **L-5 Marketplace:**
  O'Neill Fund Appeal
  Conference: The Industrialization of Space
  "Life Beyond Earth" Course
  Space Events Recordings
  Future Presentations

Cover: A 10 million ton asteroid passing close to the Earth/Moon system. A few hundred of these flying mountains (future mines for space industries) are believed to exist.

The Shuttle is for scale only. A deep space vehicle would be required to match trajectories and return. *(Cover artist is Bill Hartmann of the Planetary Sciences Institute, Tucson, Arizona).*

WE'RE GOING

by George Koopman

On California's Space Day, her limits to growthish, "small is beautiful" Governor Brown turned and stepped squarely into the future.

Late Thursday evening, a few hours before the Enterprise came floating successfully down out of the desert sky, a friend and I stood in a quiet moment in his living room, grinning like two schoolkids, and shook hands. The species had done it: We were going to Space!

BROWN: "THE EVERLASTING FRONTIER"

Our celebration was not premature. Earlier that day we'd sat in a large crowded hall at the Los Angeles Museum of Science and Industry and witnessed an event as important to the future of space as the milestone flight of the Shuttle itself. Jerry Brown, California's limits to growthish, "small is beautiful" Governor, turned and stepped squarely into the future. He opened Space Day, as the event was dubbed, by noting the continued need to respect certain limits here on Earth. But in space and the universe the governor saw no limits, and sensed "not only immediate benefits in a practical economic sense, but in a far more profound way for the people of this Earth." Taking an extraterrestrial viewpoint, he saw "the oneness of the human race," and observed that we were psychologically limited by the notion of closing frontiers, "jeopardizing the democratic fabric itself." The frontier, he emphasized, is certainly not closed: "It's just opening up in space."

"It's only a question of when and who and what kind of leadership will be taking us there. And I, for one, don't think we ought to just be looking down here below. If we look back in history, the human problems in Spain, when Isabella launched Columbus on his discovery, were greater than they are today. And after all those years, I'm not sure they've improved all that much. But you have to keep going. You have to keep pushing, because that is the human impulse. Instead of fighting it or ignoring it, we ought to develop it and respect it and encourage it and celebrate it. And that's why we're here. Because the potential of this State and this Country and this species has just begun to be tapped. It's just a matter of courage, it's a matter of investment, it's a matter of work, it's a matter of collective effort and common purpose.

"That's been the destiny of California, of America, and it's going to be the destiny of this world as those of us in this room and those of us on this planet work together to push back the new frontier which is the everlasting frontier: Space. The Universe itself!"

There was loud applause: Jerry Brown had just swung his considerable weight, and to no small extent his political future, behind the new space movement. He introduced his Cabinet; they'd come down from Sacramento for Space Day, too. He gently reminded those assembled that California's burgeoning budget surplus was just shy of NASA's total budget, fueling rumors that California was ready to deal directly with NASA and loft its own satellite solar power station. And he made a special point of introducing his Special Assistant; ecologist, former Merry Prankster and Whole Earth cataloguer Stewart Brand, the man who turned Jerry Brown on to Space. Brand, the Governor said, had shown him that "Ecology and technology find a unity in space exploration." More applause.

Space Day was on. Luminaries abounded. Chaired by Astronaut Rusty Schweickart, now Ambassador plenipotentiary from NASA to California, the program was an impressive smorgasboard of space and its future. The recipe:

Take several hundred lean and hungry aerospace industry leaders and mix liberally with large contingents of NASA spaceocrats, government bureaucrats and media folk in an environment produced by the combined clout of the Governor's office and Rockwell's best. Fold in prominent futurists, environmentalists and a generous pinch of the military. Add a dash of Trekkies and assorted serious space freaks. Blend harmoniously in an appropriate California setting on the eve of the first free flight of the Enterprise, seasoning well with the ideas of Gerry O'Neill, the results of the third NASA Summer Study and a large measure of good old-fashioned American excitement. Serve with evolutionary awareness.

FROSCH: IT'S EYES UPWARD

The next speaker was NASA's new Administrator, Dr. Robert Frosch, who reflected upon the was, is and can be of space in a talk entitled "Space: Which Way is Up?" Exploration is the "human cultural imperative," he proclaimed, and going to space "the continuation of something we've always done." He noted that the Stone Age builders of the observatory and computer at Stonehenge probably had to face the same questioning of resource use and priorities as the space explorers of today. And a few quick side calculations showed that the level of effort required to build Stonehenge would be roughly equivalent, in modern terms, to a planetary mission, say the Jupiter Orbiter Probe.

After a reasoned review of the near term prospects and benefits of the Shuttle, he commented on the origins of the ubiquitous technologies of our modem society. Looking back from Einstein to Newton, Kepler and Galileo he deduced "It all started with Astronomy."

Frosch pointed out that, for him, the main significance of the Shuttle was not merely to do the known better, but to find the new possibilities. He rang in clearly on the side of the pioneers: "The question of 'how can we afford to do it?' is backwards. Given history, and given the answers that the Stonehenge people gave to the questions they must have asked, is it really possible for the richest country in the world to say that right here and now we decide that the entire thrust of intellectual history that looked outward from Earth was wrong?"

He concluded that we can not stop "because of what this kind of thing has always meant to the human race. We are now in a period of consolidating and understanding what we have learned from the first era, the First Age of Space, and preparing to see what it is we will do, and where it is we want to go, and how we want to go there, in the succeeding Ages of Space."

NASA's Administrator also fielded questions from a panel chaired by Stewart Brand, and sounded at times more like the Director of Marketing pitching the clients than a theoretical physicist turned manager. The image emerging from his remarks was clearly one of NASA in transition from a "because it's there" explorer to a robust serviceperson of the future.

SAGAN: COST OF A VIETNAM WAR?

Next up was Space's answer to Johnny Carson, explorer of the planets Dr. Carl Sagan. He echoed what was to be a central theme of the day; the line of human endeavor and exploration leading to space, and the parallels with the European voyages of discovery to the New World. "The fraction of the national budgets of Holland, Spain, England or France that were devoted to sailing ship journeys of exploration and discovery in those centuries was something like ten times the fraction that the NASA budget represents of the Federal budget in this country."

He went on to review the many deep practical reasons and justifications for planetary exploration, drawing examples from the cross-impact on a wide range of sciences, from climatology and geology to biology. Sagan also showed slides of the best returns form our extraterrestial cameras, rhapsodizing about remarkable features on that planet and this, plugging his vision of how we will better know "the origin, nature and destiny of worlds."

Dr. Sagan did not, however, confine himself to planetary robotics. Without naming names, he took what some regarded as a cheap shot at the vision of space colonization, equating its cost to "one Vietnam War; between one and two hundred billion dollars." And he went on to say that "The initial cost of space colonization is so large that it's not obvious that it's the direction we should go."

He did not go unanswered.

O'NEILL: TIME TO STOP LETTING ARTOO DETOO HAVE ALL THE FUN

Dr. Gerard K. O'Neill came to the mike and wasted no time putting his colleague gently but firmly back on track: "First of all, for Carl's benefit, he hasn't been reading the literature recently. The last estimates on the costs of the kinds of things I'm talking about are a lot lower than he mentioned." And for those who would save money and send robots, he noted that Darwin and Magellan and Armstrong, Mitchell and Schweikart had gone themselves:

"We're now in a tremendously useful and productive period of space exploration, which we must honestly describe as timid. Not because of the timidity of people within NASA, but because of the timidity of the people who give them money. These days we send robots into space instead of going ourselves. And much as we all love Artoo Detoo, I think it's about time we stopped letting him have all the fun. A byproduct of a vigorous thrust into space should be a direct human involvement again."

Gerry went on to prove that a picture is worth a thousand words by illustrating his talk with the many beautiful renderings of life on Island Threes and Bernal Spheres familiar to readers of the L-5 News. Point made.

Space Day also featured Dr. Robert Cooper, Director of the Goddard Spaceflight Center, speaking on applied space research; Dr. Chris Kraft, Jr., Director of the Johnson Space Center on satellite solar power; and Dr. Burt Edelson, Director of the Comsat Labs, on the future of satellite communications. Robert Anderson, President of the Shuttle's builder, Rockwell International, seconded the Governor's theme in a talk on California and Space; and Dr. Bruce Murray scanned the horizons of new techniques and technologies from his vantagepoint as Director of the Jet Propulsion Laboratories.

The universality of the appeal of space was brought home by the appearance on the platform of one of the planet's grand men of exploration, Captain Jacques Cousteau, who lent his enormous prestige and presence to the occasion. His remarks were to the point: We can save the oceans by providing invaluable information on their condition from remote sensors in space.

And lest we forget that this whole party was a joyful send-off for the Enterprise, astronaut Deke Slayton, NASA's Manager of the Approach and Landing Test, briefed us all on the events to take place the following day at Edwards Air Force Base.

The space celebration also included an elegantly catered luncheon for the thousand-plus guests served on trays, by the fountain of the Museum's spacious Rose Garden. Rockwell and several other aerospace concerns had large convention style booths, and solar heated coffee was available on the lawn. The famous M.I.T. mass driver model was on hand, and Gerry O'Neill's students demonstrated it with showman-like flair. A new and stimulating movie, "Space Borne" was also shown at the beginning and end of Space Day.

BROWN: "IT'S ALL THERE JUST WAITING FOR YOU"

In his closing remarks Governor Brown emphasized the importance of the day. A remarkable collection of interests had been brought together, covering "the range of human potential" and representing the exciting possibilities of the shuttle for everyone on the planet. He reviewed the practical present applications of space technology, and equated the flight of the Enterprise to the driving of the Golden Spike on the first transcontinental railroad, predicting that we in the room would indeed see our dreams realized, "looking to the future with confidence, with expectation and collective purpose, to realize the common purpose of this whole species." He concluded: 'It's all there just waiting for you and the rest of the people who stand behind you throughout this

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About the author: George A. Koopman is President of INSGROUP, Inc. (INstructional Systems GROUP) of Huntington Beach, California, designers, developers and producers of audio-visual programs and products.

He is partner and Director of Future Presentations, a Los Angeles-based lecture bureau representing speakers on future-oriented topics such as space industrializatiigration, extra-terrestrial intelligence and life extension.

Mr. Koopman is also the Executive Producer of "The Joyful Wisdom Program," a nationally syndicated weekly radio program with a futuristic outlook. His comments on space industrialization werecarried in the recent "Shuttle" issue of Business Week.

world waiting to get into space, go into the oceans, to understand ourselves, and to create the quality of life that our evolutionary potential justifies. Thank you."

The feeling with which we left was simple and profound. For the women and men who had been running around the planet-face, regarded by many of our fellow humans as a little strange, talking about living and working in space, it was clear: We have achieved critical mass. It is really going to happen. The many elements necessary have been brought together, not the least of which is the personal political and economic weight of the state and its Governor.

The night ride to Edwards was beautiful. An hour before dawn we were herded across a vast dusty mountainside with thousands of other cars, and parked all in a row to gaze down at the Shuttle and its mother 747 bathed in lights and surrounded by rustproof red scaffolding on the ramp far below. The overture was exceptional: In the East rose Jupiter, then Venus and the old sliver of the Moon. The high desert clouds reflected the sunlight before our home star made its appearance in a sunrise that was more than any director could have desired.

The scene of the mountainside was American! Campers, dogs, kids, hawkers selling comemorative T-shirts. Telescopes and monoculars and shortwave radios and cameras were set up and tried out. The old and the young were there, not a few of the latter aware that they could, in reality now, dream the dreams of future Star Fleet commanders. Hippies and aerospace engineers looking around to wonder if they were in the right place; or was this an Eve1 Knevel spectacular? The cars kept coming, and the radio informed us that traffic was backed up two miles waiting to get onto the base.

The scaffolding was pulled back now, and the most unlikely looking couple in aeronautical history moved slowly and grandly across in front of us, out towards the dry lake bed. Across the vast desert scurried cars and emergency vehicles, small dots positioning themselves out on the runways. Overhead flashed pairs of T-38's, the chase planes, white and light and orbiting the grand scene. Lower came the NASA and Air Force choppers; counting the crowd no doubt, worryingabout traffic and filming it all.

The local radio station, which was supposed to be carrying the live command channel conversations between the Shuttle, 747, chase planes and the ground was earning the universal enmity of most everyone tuned in by running snatches of the conversations between great hunks of mediocre country western music and ads for the local car dealers.

And far off, at the near end of on of the best and longest runways on the planet, they started to roll. Slowly and surely they lifted off. The command channel was finally coming in live, and the matter-of-fact tones of pilots and astronauts and Mission Control only sharpened the senses on the hillside, where a hundred thousand pairs of eyes watched as the Enterprise and her retinue climbed into the distance, slowly disappearing to a point. The wait was agonizing, till having traced a giant circle the ensemble reappeared, coming overhead at 20,000 feet. The jumbo jet was clearly visible, and the chase planes were tiny white dots; three on one side, one on the other. The command link was still except for the occasional professional comments reading off altitude, heading, requests for a chase plane to move in for a look at this or that, and the cool voice of Mission Control. Still reaching for altitude the planes bore on across the base and off to once again disappear from view.

It was getting hot on the ground; probably close to a hundred. Separation was coming up, and we couldn't see it. We didn't see it. The Enterprise was flying free, and the hillside was a mass of searching eyes and pointing hand. Where was she? Arms pointing to the Zenith. Two white dots. No. That was Jupiter and Venus, still visible. More than a minute since separation. Where was she? Planes overhead, way up. No, that was the 747, still with one chase plane.

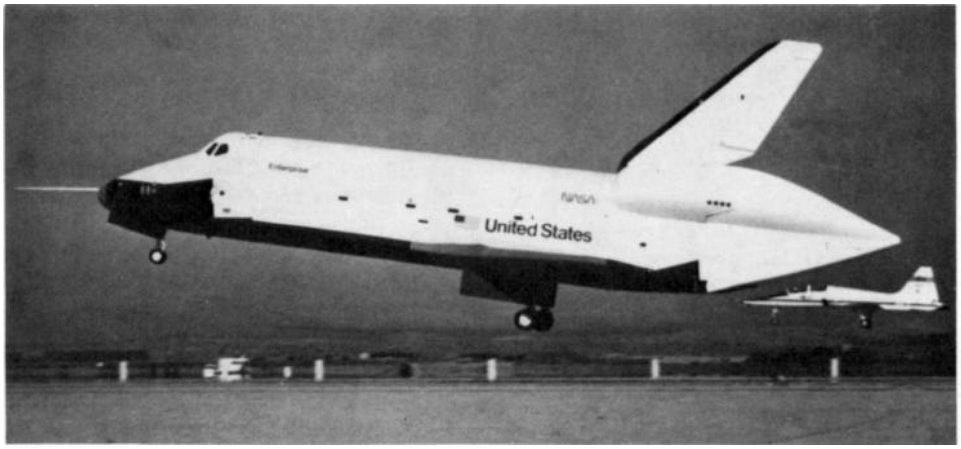
"LIKE SOME FANTASTIC FLYING SHARK"

And then all the arms and eyes pointed together and out of the East, like some fantastic flying shark complete with three white pilot fish came the Enterprise; floating, flying, gliding down home smoothly in a curve that brought her cleanly and precisely over the end of the dry lake, and a joyful cheer from the mountainside, and quick silence again as her altitude became double digits and single digits and she was down in an

enormous cloud of dust that went on and on and she stopped rolling. Cheers and cheers again and not a few tears.

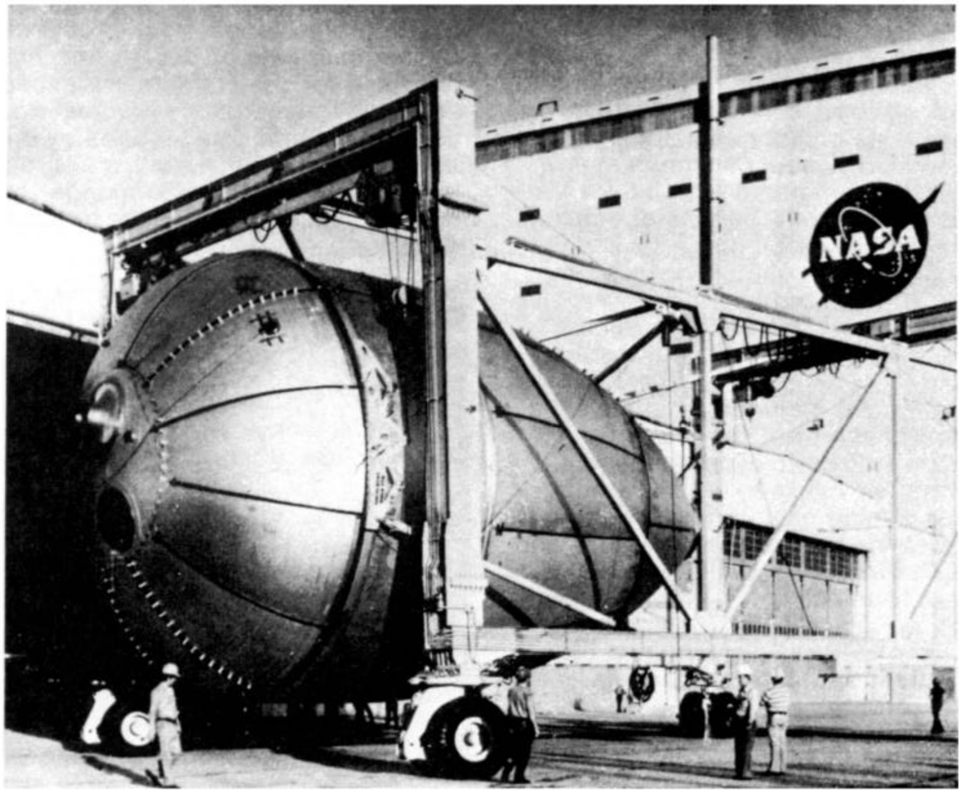
And so it was that in the summer of her two hundred and first year, America, with vision both revolutionary and evolutionary, gave birth to the Third Industrial Age, and she was called Enterprise, and it was good. The technological portion of this achievement was of course extraordinary, in the spirit of the best that this country can produce, unrivaled on the planet. But the vision evidenced in the human commitment to go to space as a species is an achievement transcending the technological, a spiritual undertaking as profound as any in recorded history. It means, quite literally, that we have consciously participated in the evolution of the race.

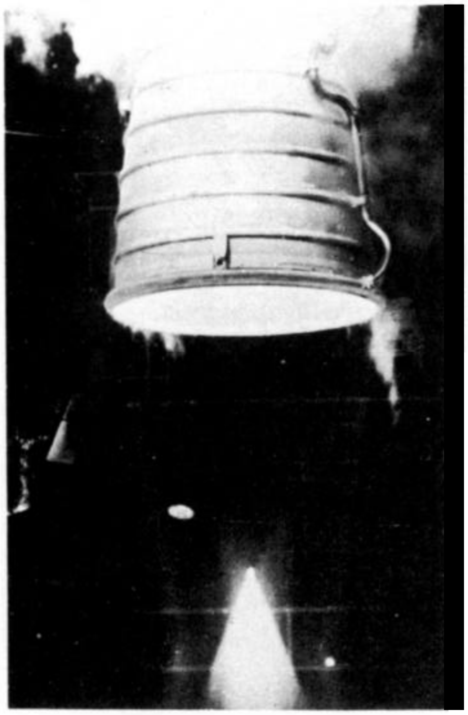
The New Worlds to be found on this voyage of discovery will, of course, include the not so unknown worlds of solar power, global communication, and generally better life on the home planet. But the real unknown is no longer unknown spaces and undiscovered natural resources, as it was for the European pioneers. Rather, it is that in returning to the universe from whence we were born, we will evolve into the next species, ourselves in the future and look back to see this important milestone not only in the technological but also in the humanistic frame of reference. •



Shuttle Milestones

The first completed liquid oxygen tank for the Space Shuttle's external tank moves toward the vertical test area at the Marshall center's Michoud facility in New Orleans, where it recently underwent proof pressure testing. The black strips along the sides are made of a special moisture sensing material that detects minute leaks at the weld joints. All tanks-manufactured by the Martin Marietta Corp.-will undergo similar proof testing before flight. This tank will be used in MSFC's main propulsion test program at the National Space Technology Laboratories (Miss.) starting in December 1977.





The first Space Shuttle main engine has been tested successfully at rated thrust conditions for 60 seconds with a total test duration of slightly more than 80 seconds. A major Shuttle project milestone, the firing was conducted by Rocketdyne Co. personnel under direction of the Marshall center at NASA's National Space Technology Laboratories. It was achieved on Engine 0003 in A-l sea-level test position. This is the first rocket engine designed for repeated use and the first engine controlled by computers. Operating at high combustion pressures, it is more powerful for its size than any rocket engine previously developed. Designed to provide 7½ hours of flight operation and 55 re-uses before overhaul, it will bum for approximately 8½ minutes during a nominal Shuttle mission. It produces 470,000 pounds of thrust at rated vacuum conditions.

ORBITER TESTS

TAXI TESTS: February 15. 1977

Three taxi tests assessed the mated capability of the Shuttle Orbiter piggyback atop the 747 in ground handling and control characteristics up to the flight takeoff speed. The tests also validated the 747 steering and braking.

Weight of the 747 at the start of ‘the taxi tests was approximately 400,000 lbs. and the Orbiter weight was approximately 144,000 lbs. The nose of the mated Orbiter is at a +6 degree altitude atop the 747.

The taxi tests were performed incrementally at various speeds. Taxi Test #l speed was 89 mph and the 747 brakes were applied at 27 mph; Taxi Test #2 speed was 140 mph with the 747 brakes applied at 23 mph: and Taxi Test #3 speed was 157 mph with 747 brakes applied between 57 and 46 mph.

Successful completion of the taxi tests permitted the "go" for the first inert Orbiter captive flight.

FLIGHT #1: February 18, 1977

Duration: 2 Hr. 5 Mins.
Maximum Speed: 287 MPH
Maximum Altitude: 16,000 Ft.

This flight obtained information on low-speed performance and handling qualities of the mated "crafts" and was accomplished almost exactly as planned. The 747 combined with the Orbiter handled much closer to the standard 747 than was anticipated. The 747 crew stated "they couldn't even tell the Orbiter was aboard." The 747 mated with the Orbiter totals a much lower gross weight than a fully-loadedcommercial 747 traveling from Los Angeles to London.

FLIGHT #2: February 22. 1977

Duration: 3 Hr. 13 Mins.
Maximum Speed: 328 MPH
Maximum Altitude: 22,600 Ft.

Flight #2 accomplished a series of flutter and stability control tests. During this flight, the two right engines of the 747 were reduced to idle thrust. The flight was termed "super."

FLIGHT #3: February 25, 1977

Duration: 2 Hr. 28 Mins.
Maximum Speed: 425 MPH
Maximum Altitude: 26,600 Ft.

This flight concluded the flutter tests and concentrated on stability/control/flight evaluation and airspeed calibration. Stability and control were evaluated by idling the #4 engine of the 747 to simulate an engine failure.

At the completion of this flight, it was stated that if flights #4 and #5 follow the same successful pattern, flight #6 would not be necessary.

FLIGHT #4: February 28. 1977

Duration: 2 Hr. **11** Mins.
Maximum Speed: 425 MPH
Maximum Altitude: 28,565 Ft.

This flight simulated emergency descent of the mated vehicles and a missed landing approach, as well as maneuvers required of the 747 when the mated vehiclesenter the separation flight phase.

The emergency descent was accomplished by reducing the four 747 engines to idle thrust. The missed approach was performed by flying the mated vehicles over the runway within several feet of the ground, then returning the 747's four engines to power and flown around for the final approach and landing.

Full braking of the 747 was used for the first time upon landing in a simulated "short" runway situation. 747 braked to stop in less than 6,000 ft.

FLIGHT #5: March 2. 1977

Duration: 1 Hr. 39 Mins.
Maximum Speed: 474 MPH
Maximum Altitude: 30,000 Ft.

This flight performed two simulations of the flight profiles which will be used when the Orbiter is separated from the 747 in the third and final test phase. The two simulation release flights were performed successfully. Because an altitude of 30,000 ft. was reached it was possible to simulate the separation at about 25,000 ft.

In addition, the short runway landing was again achieved. This simulated NASA Marshall Space Flight Center's 7,500 ft. runway at Huntsville, Alabama. The mated vehicle configuration will be utilized to ferry the Orbiter to the Marshall Space Flight Center next year where the Orbiter will undergo a vertical ground biration test program with the External Tank and Solid Rocket Boosters.

As a result of the success with the five flights, it was determined that the sixth flight was not required.

PHASE II APPROACH AND LANDING TESTS (Piloted Flights)

FLIGHT #l: June 18, 1977

SCA/Orbiter Brake Release: 8:06 A.M. (PDT)
SCA/Orbiter Landing: 9:01:46 A.M. (PDT)
SCA/Orbiter Weight: 263,088 Kilograms
(580,900 lbs.)
Flight Duration: 55 Mins. 46 Secs.
Maximum Speed: 181 KEAS (208 MPH)
Maximum Altitude: 4562 Meters (14,970 Ft.)

Spacecraft Commander Fred Haise and Pilot Gordon Fullerton were at the controls of the Space Shuttle Orbiter during this first manned captive flight. This flight was a once around a racetrack-like flight path which measured approximately 125 kilometers (78 statute miles) on the "straight-a-ways" with 16 kilometer (10 statute mile) curves.

The Orbiter's onboard electrical power (fuel cells), auxiliary power units, hydraulic and coolant systems were activated prior to takeoff.

During the initial climb-out, low-speed flight control system tests were performed. When the mated craft reached approximately 4,562 meters (14,970 ft.), the SCA flaps were positioned to 10 degrees and speed was maintained at approximately 181 KEAS (knots equivalent airspeed -- statute mph).

After the first turn of the racetrack-like trajectory, a flutter test was performed by the actuation of the orbiter's flight control surfaces, then the SCA flight control surfaces; the Orbiter's speedbrake was opened to 60, 80, and 100 per cent; a test of the Orbiter's gyros was performed, and the Orbiter's flight control system and surface deflection were checked.

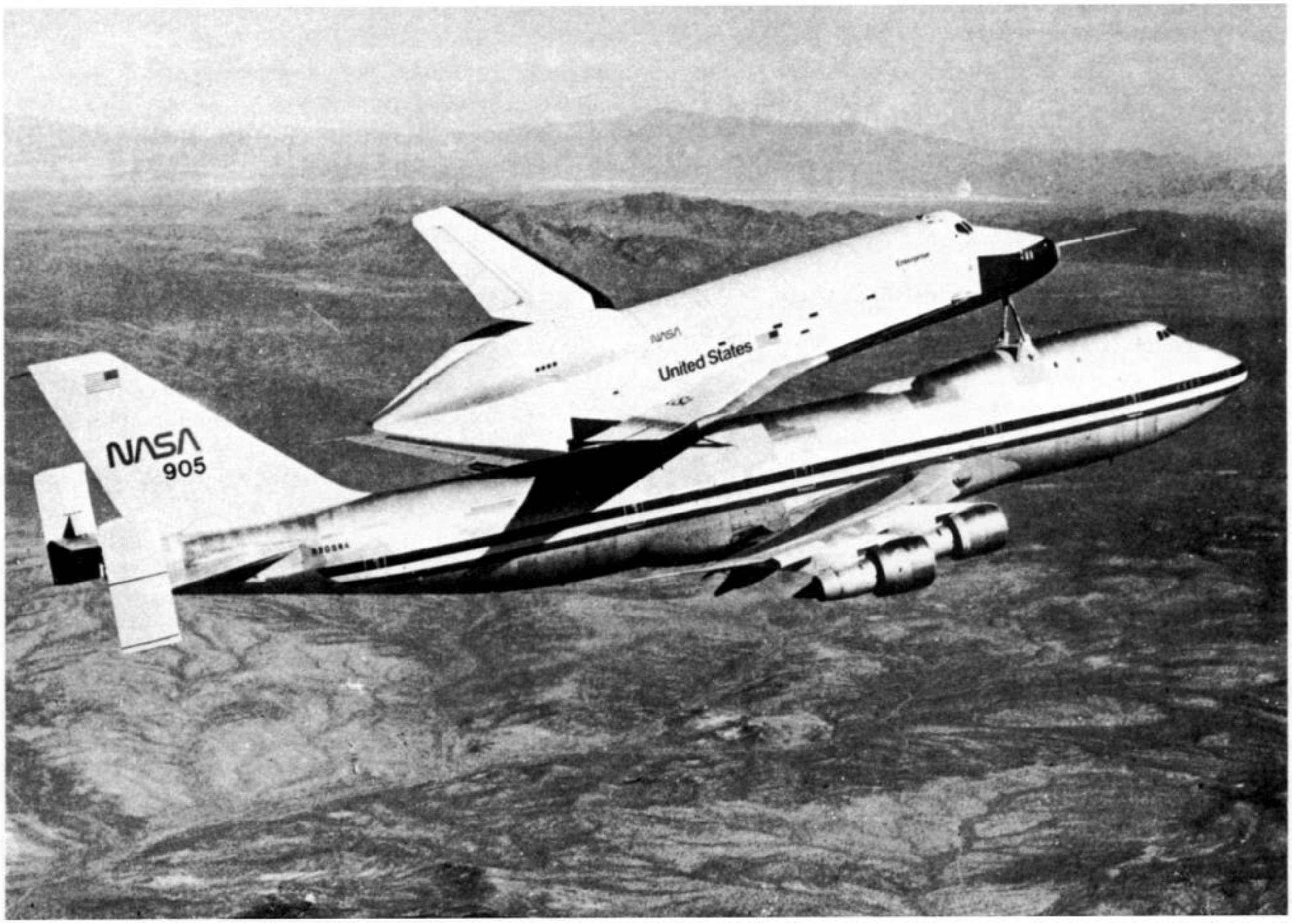
This first manned captive flight was originally scheduled 24 hours earlier; however, during pre-flight checkout, three of the onboard computers "voted out" a fourth. This "rejected" computer was replaced. There are four onboard computers which operate redundantly to provide commands to the various orbiter systems. According to mission rules, the Orbiter may be flown with three computers operating, but program officials decided to postpone the flight one day. There is a fifth computer onboard which operates a back-up flight control system independent of the other four for additional redundancy.

FLIGHT #2: June 28. 1977

SCA/Orbiter Brake Release: 7:49:50 A.M. (PDT)
SCA/Orbiter Landing: 8:52 A.M. (PDT)
SCA/Orbiter Weight: 253,018 Kilograms
(557.800 lbs.)
Flight Duration: 1 Hr. 2 Mins.
Maximum Speed: 270 KEAS (310 MPH)
Maximum Altitude: 6714 Meters (22.030 ft.)

Spacecraft Commander Joe Engle and Pilot Dick Truly were at the controls of the Space Shuttle Orbiter during this second manned captive flight. This flight consisted of a modified racetrack-like trajectory as well as a "Grand Prix" roadrace-like trajectory.

The Orbiter's onboard electrical power (fuel cells), auxiliary power units, hydraulic and



A totally successful first flight of the mated Boeing 747 carrier jet and orbiter, Enterprise, took place at the Dryden Flight Research Center on Feb. 18.

coolant systems were activated prior to takeoff.

During the initial climb-out, low-speed flight control system tests were performed. This low-speed flutter test was performed with the Orbiter's flight control surfaces activated first, then the 747 SCA's control surfaces were operated with the mated craft at a speed of approximately 225 KEAS (259 mph). Following the low-speed flutter test, the Orbiter's speedbrake was opened to a 60, 80, and 100 per cent deployment.

The SCA crew then applied Special Rated Thrust (SRT) to the 747 engines for the climb, a pushover, and acceleration of the mated craft to approximately 270 KEAS (310 mph). The Orbiter and SCA crews again applied inputs to their respective craft control surfaces for a high-speed flutter test followed again by the deployment of the Orbiter's speedbrake at a 60, 80, and 100 per cent deployment. The low and high speed flutter tests assessed the accuracy of predicted control surface responses and structural characteristics with respect to aerodynamic vibration.

The mated craft then climbed again to an altitude of approximately 6,187 meters (20,300 ft.) for a separation maneuver test. The 747 crew accomplished a pushover and acceleration of the mated craft to approximately 270 KEAS (310 mph), with a descent rate of approximately 914 meters (3.000 ft.) per minute. The Orbiter's elevons and ailerons were positioned to provide the optimum Orbiter control surface positioning for the actual release maneuver in Phase III ALT.

Following the separation trajectory test, the mated Orbiter/SCA climbed again to approximately 5,882 meters (19.300 ft.), accomplished a pushover and established a 747 glide slope of approximately six degrees for an Orbiter AUTOLAND made fly-through. At this time the Orbiter crew monitored the Orbiter's Horizontal Situation Indicators which operated in conjunction with the MSBLS (Microwave Scan Beam Landing System). The combined craft then established a normal approach for landing.

The results of the flutter, separation maneuver and AUTOLAND tests were well within the tolerances expected by program officials.

FLIGHT #3: July 26. 1977

SCA/Orbiter Weight: 565,000 lbs.
Duration: 59 Mins. 53 Sec.
Maximum Speed: 312 mph
Maximum Altitude: 27,992 ft. (AGL)

Spacecraft Commander Hise end Pilot Fullerton were at the controls of Enterprise during this third and final captive flight, a full dress rehearsal of the planned August 12 free flight. The SCA/Orbiter reached a maximum altitude of 27,992 ft. (AGL) at which time pitch over was performed. The carrier aircraft landing gear was deployed to simulate the free flight approach and landing profile. A practice separation run was normal and "abort separation" was performed one minute after pushover. Enterprise landing gear was deployed for the first time after the SCA landed on runway 22. The final approach profile was identical to that planned for the first free flight.

Shuttle Free Flight

Technical Details

Shuttle Orbiter *Enterprise*, with astronauts Fred W. Haise and C. Cordon Fullerton at the controls, was released from atop a 747 carrier aircraft for the first free flight approach and landing test (ALT) at NASA's Dryden Flight Research Center, Edwards, California, August 12, 1977.

Haise and Fullerton flew the 75-ton Orbiter to an unpowered landing on a dry lake runway after explosive bolts released the Orbiter from its 747 carrier aircraft at an altitude of about 6,738 meters (22.100 feet) above ground level. The free flight of the Orbiter took about five minutes.

This initial solo flight followed a series of unpiloted and piloted captive test flights conducted at Dryden which began in mid-February. The Orbiter was carried aloft for a series of five "inert" flights (Orbiter systems inoperative) before astronauts Haise and Fullerton and fellow ALT crew members Joe Engle and Richard Truly flew subsequent captive flights

The captive flights verified the aerodynamic and handling capabilities of the 747/0rbiter combination as well as Orbiter systems and crew procedures.

Astronauts Engle and Truly will pilot *Enterprise* during the second flight, tentatively scheduled for about three to four weeks later.

A series of free flights is currently scheduled with the Shuttle Carrier Aircraft (SCA-747) serving as the airborne platform from which the Orbiter will be launched. These flights, with NASA astronauts at the controls of the unpowered Orbiter, are designed to verify the Orbiter's subsonic air-worthiness, integrated systems operations and pilot-guided and automatic approach and landing capabilities.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used a minimum of 100 times. It is as big as a commercial jetliner (DC-9); its empty weight is 68,000 kg. (150,000 lb.); it is 37.2 m (122 ft.) in length and it has a wingspan of 23.8 m (78 ft.). The Orbiter is to be launched into low Earth orbit in 1979 with its three main engines augmented by a pair of solid rocket boosters.

The Space Shuttle is composed of the Orbiter, the two solid rocket boosters and an external fuel tank which feeds the Orbiter's three engines.

The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid boosters will be recovered, refurbished and reused. The external tank will be jettisoned but not recovered.

Enterprise, the first Orbiter (101) to be used in the Dryden flight test program, is the first development article of the Shuttle program to come off the assembly line. Under construction since June 19, 1974, Enterprise's main parts come from numerous aerospace contractors throughout the country. The crew module and aft fuselage were fabricated by the prime contractor, Rockwell International's Space Division, Downey, California; the mid-fuselage (cargo bay) by General Dynamics, San Diego, California; wings by Grumman Aerospace Corp. of Bethpage, N.Y.; and its tail assembly by Fairchild Republic Co., Farmingdale, N.Y.

The Orbiter's three main engines, each of which provide 2.1 million newtons (470,000 lb.) of thrust at launch, are being built by the Rocketdyne Division, Rockwell International, Canoga Park, California.

Enterprise was transferred from the Rockwell International assembly plant at Palmdale, California, to the Dryden Center January 31, 1977. At completion of ALT, this first Orbiter will be ferried atop the SCA to NASA's Marshall Space Flight Center, Huntsville, Ala., where it will undergo extensive ground vibration tests. Subsequent to these tests it will return to the Rockwell facility at Palmdale and be prepared for orbital flight sometime in the early 1980's.

The second Orbiter (102), currently under construction, will be the first vehicle to be used in the Shuttle Orbital Flight Test (OFT) program which is scheduled to begin in 1979. Six OFT flightsare planned to demonstrate the Orbiter'scapabilities in Earth orbit before the Shuttle becomes operational in 1980.

'77 NASA SUMMER STUDY:
No Show Stoppers!

Study Team Finds Apollo Scale Effort Can Bring Solar Power Satellites, Space Cities on Line by 1990

by Carolyn Henson

Will the 1977 Summer Study on Space Manufacturing Facilities (SMF) be the last of its kind? This year's team, like those who had worked on the concept in the summers of 1975 and 1976, concluded that there were no insurmountable technical barriers and that the economics were promising. But, at a briefing given August 2, study leader Gerard K. O'Neill advised the reporters, industry representatives, NASA officials and spectators packing the Ames Research Center auditorium that "We need to go to a continuous effort." He revealed that all 5 of the subgroups in this year's study hoped to continue workingon the SMF concept, adding that "bandaid funding won't be enough for long."

According to O'Neill, NASA is trying to scrape up additional SMF funds from its already lean budget. But NASA watchers agree that the hard-pressed agency will have to go to Congress next January (if Office of Management and Budget Director Bert Lance will permit them) to ask for a line item in the fiscal year '79 budget for the SMF approach to solar power satellites (SPS) in order to be able to mount the full-time research effort O'Neill proposes.

O'Neill told the crowded auditorium that "by 1980 we could begin a Shuttle flight test program for SMF." He predicted the first liftoff for construction of the SMF -- given a go-ahead by Carter in '78 -- would occur in 1985, and that energy would be delivered from space by 1991. "The first solar power satellite," explained O'Neill, "would provide enough electricity to power all of Los Angeles."

John Shettler, on loan to the study team from General Motors, described the study's proposed scenario in detail. The pricetag? 'Comparable to Apollo -- about $66 billion." The schedule? Proposing a hypothetical "Space Gateway Corporation." Shettler outlined their production schedule. By March. 1987, the lunar mining base, source of the SMF's raw materials, would be established. By November, 1989, the SMF, located in a circular orbit 50,000 km from the Earth's surface (partisans of the 2:l resonant and

Exterior of a space-habitat for some 10,000 people. The inhabitants, members of the workforce of a space manufacturing complex. would return after work to homes on the inner surface of a large sphere, nearly a mile in circumference, rotating to provide them with gravity comparable to that of the Earth. Their habitat would be fully shielded against cosmic rays and solar flares by a non-rotating spherical shell, accumulated from the slag of industrial processes carried out on lunar surface material. Outside the shieldcd area agricultural crops, far less sensitive to radiation than arc humans, would be grown in the intense sunlight of space.

L-5 orbits, take note!), would boast 3,000 workers. The first SPS would roll off the production line in December of 1990; the second, in December, 1991, and the third in April 1992. By the year 2004 Space Gateway Corp., with 50,000 SPS space construction workers, would be supplying the electrical needs of the entire world.

After his talk, people crowded around Shettler, asking him where they could buy stock in Space Gateway. Shettler gently explained to the disappointed investors that Space Gateway was merely a rhetorical device; and, as O'Neill pointed out later in the briefing, "They (corporations) only go ahead when the technical risk has been cut down to l%."

So, it looks as if at present the major thrust of the SMF project will remain in the hands of the U.S. government and researcher's hopes are fixed on the possibility Congress and Carter will choose to fund them.

O'Neill Summer Study Notes

by Gerard O'Neill

The 1977 NASA-Ames Summer Study was the largest yet conducted on the subject of space manufacturing and space settlements. More than fifty people took part, from universities, government, and private industry. The study addressed several short-term technical issues vital for the achievement of a low-cost, high return program of manufacturing in space from non-terrestrial materials. The goal in those studies was the production of satellite solar power stations to send clean energy to the earth within the next two decades.

Details of solar satellite design were not addressed, because these have been covered by other NASA studies. Instead, the summer study looked at ways to use the Space Shuttle system, beginning in the 1980's to set up a small mining and transport base on the surface of the moon, shipping materials out to a precise point in free space. From there many thousands of tons of lunar materials could be transported to a high orbit above the earth to be processed with solar energy into metals, glass, silicon and oxygen. These pure elements would then be used to construct satellite solar power stations, each weighing as much as an ocean liner.

Several of the study groups worked on problems of great importance, but not on the "critical path" for the first years of space manufacturing. One group worked out a plan for the necessary research to insure that crops can be grown and farm animals raised in space, using the results of the latest work done on greenhouse-agriculture on the earth.

Another group looked at the most efficient designs for space habitats and calculated the costs of providing earth-normal gravity for the workers in space by habitat rotation. Still another group found ingenious ways to return nearby asteroids to high orbit, using gravity-assist "swingby" methods worked out during previous space missions.

The study concludes that no "show stoppers" have been found, and that with the recent hard work many problems now look easier than they did earlier. At the same time, a great program of research and development, comparable to that of the Apollo project, lies ahead if space manufacturing is to be realized.

We feel that further research at a much more intensive level *is* needed, as soon as possible, both to find whether such "show-stoppers" exist at a deeper level, or if not, exactly how best and most efficiently to design the many components of a space-manufacturing system.

If the necessary research is done quickly, we feel that the first Shuttle flights carrying components of a space-manufacturing system could lift off by the mid 1980's, and that significant amounts of clean electrical energy obtained from solar satellites in high orbit could begin to flow into our power lines on earth by the early 1990's. By the turn of the century most of our new electric generating capacity could be in the form of solar satellites, rather than coal or nuclear plants. Alternatively, a less aggressive program, taking plenty of time to explore alternatives, and conducted at the deliberate pace of government decisions in this decade rather than with the sense of urgency we felt during the Apollo Project, might give the same benefits, but five or ten years later.

Our suggested program would make heavy use of the Space Shuttle, due to make its first free flight this month. We would use the Shuttle to lift to low orbit all the components needed for the first space-manufacturing system, and all the people needed to operate it. We would use the Shuttle's external tanks to make modular living-quarters for use in low and high orbit and on the lunar surface. Other tanks of that kind would be pelletized to form reaction-mass, expelled by mass-drivers to lift Shuttle payloads to lunar orbit. Though we would begin our program by carrying up from the earth all the food needed by workers in space, eventually we would switch to space-agriculture, using the unlimited solar energy available in high orbit.

From our six weeks of intensive study by fifty people, we feel that it is time to augment our efforts by an intensive, hard-driving program of research and development on a most attractive option.

More On Space Freeport

by Mark Frazier

The space freeport project is beginning to move. In recent weeks the following developments have occurred:

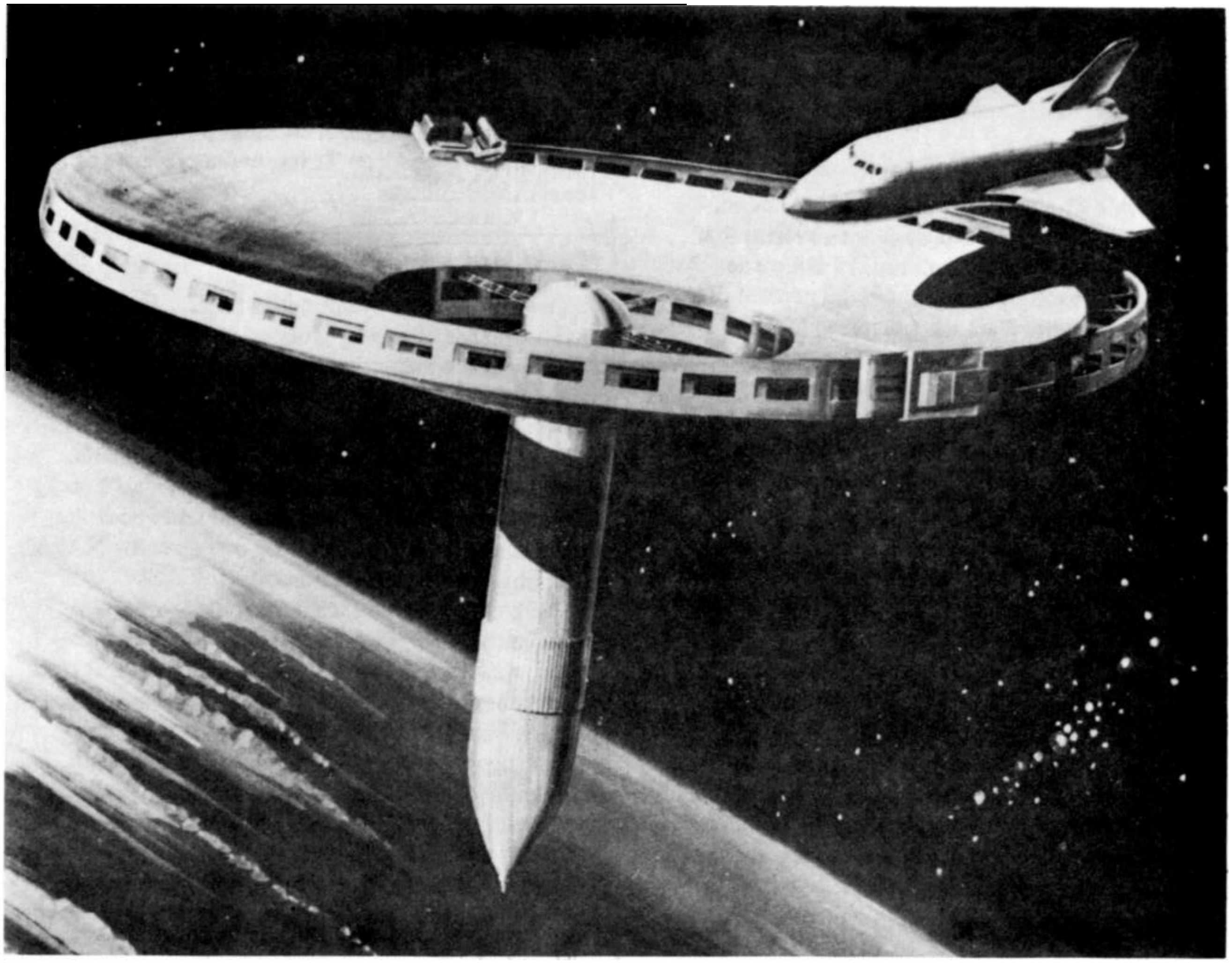
1. *Funding*. OTRAG, A West German company, has indicated that it will make a contribution to the study. OTRAG became the first corporation in space this May, when it lofted the first of a series of rockets from an equatorial launch site. It expects orbital capability by next year. Headed by Dr. Kurt Debus, former head of NASA's Manned Space Flight Center at Canaveral, OTRAG has raised millions of dollars to date from investors in Europe.

2. *New advisors*. We are pleased to announce that Dr. Marcel Barrere, head of the International Astronautical Federation, has joined our advisory board, as had Ed Finch, chairman of the aerospace law committee of the American Bar Association and former ambassador to Panama. Both will bring welcome ideas and experience to the project.

3. *Upcoming conferences*. Earthport project members are organizing, or appearing in, a number of aerospace-related conferences in the future. Art Dula, chairman of our government launch activities committee, is director of the American Bar Association conference on science and technology from Aug. 4-10 in Chicago, featuring business in space: Paul Siegler, a member of our private users committee and a consultant to NASA, is organizing a conference on the industrialization of space, sponsored by the American Astronautical Society and the American Institute of Aeronautics and Astronautics. Earthport study director Mark Frazier and private users committee chairman Bob Poole will deliver papers at the conference, to be held in San Francisco beginning October 18.

4. *Contact with equatorial governments*. Translations of a letter to 43 heads of equatorial nations have been completed, and were in the mail by mid-August. The letter asks whether the nations wish to be considered as potential sites for an international free trade zone/space launch area. Dr. Irwin Pikus, acting head of the State Department's space division, has helped us in preparations for a simultaneous, similar letter to heads of telecommunications ministries in these countries. We anticipate replies during late August, September, and October.

More bulletins will follow as things progress.



"Space Spider"

"Spiders" Build in Space -- *This artist's concept depicts two proposed Teleoperator Space Spiders building a structure for a solar power satellite onto a Space Shuttle external tank. On completion of such a structure, the external tank could become a control center for space operations, a crew habitat for Shuttle astronauts and a focal point for various space missions. The Shuttle orbiter is shown at right hovering over the solar power satellite.*

NASA's Marshall Space Flight Center has issued a request for quotations to industry for a "Design Study of the Teleoperator Space Spider for Building Large Space Structures."

The "Space Spider" concept formulated by Marshall engineers involves a device that would be capable of constructing large structures such as satellite power systems and antennas in space. Carrying a roll of prestamped material, the Spider would attach itself to the rim of an established core and, traveling by means of a crawler-type drive, would spin a newly formed ribbon of material around the rim. The action would continue until a particular diameter was reached.

The Teleoperator Space Spider has been proposed for flight aboard the Space Shuttle in the 1980's.

Notes From USRA

USRA is no longer providing liaison and coordination in relation to experiments for the Long Duration Exposure Facility (LDEF) and potential experimenters should communicate directly with:

Mr. John DiBattista
LDEF Project Officer
Mail Stop 158B
NASA/Langley Research Center
Hampton, VA 23665
Telephone: (804) 827-3704

There are still a number of options available to experimenters under the NASA Announcement of Opportunity. Moreover, there are still opportunities for flight on the first LDEF missions. An additional Announcement of Opportunity is planned for late 1977.

If the research you contemplate is better suited to Spacelab, which is of shorter duration and carries people, or to other shuttle programs, please contact:

Dr. Noel Hinners
Office of Space Science
Mail Stop F 5131
NASA Headquarters
Washington, D.C. 20546
Telephone: (202) 755-2320, Ext. 53672

Inside the L-5 Society

Treasurer's Report

by Bill Weigle
Treasurer, Board of Directors

In the last fiscal year (July 1, 1976 to June 30, 1977) the Society had an income of $47,047.87.

Of this amount memberships (regular, student, institutional and renewals) brought in $15,583.00 or just over one-third. The largest category was, however, $17,298.19 in donations. This includes money donated by William O'Boyle and Barbara Marx Hubbard during the Society's times of need, as well as donations earmarked for particular projects (paying reporter's traveling expenses, production of the color pictures in the May '77 L-5 News, etc.) from George Litwin, George Koopman and the Koopman Foundation, Jay Levey, Timothy Leary, Bill O'Boyle, Jack Hopkins and Barbara Marx Hubbard. Special thanks goes to Larry Friesan who, although not wealthy, has sent in a donation every few months for the last two years, and to all the people too numerous to list who have sent in an extra five or ten dollars from time to time.

The remainder of our income came from sales of publications, books, posters, slides and back issues.

In fiscal year '77 the Society disbursed $48,899.35 placing us $1851.48 in the red as of July 1. The largest expenditure was in labor. Management services cost $10,344.09 and wages totaled $4,359.38 for a total of $14,703.47. Printing ranked next at $12,775.17. This includes L-5 News printing and special mailings. Photocopy services cost $4,230.62. (This expense should drop as the Society has just acquired its own machine and is also standardising printing to avoid tons of "rush" printing done by photocopier.)

Postage and handling excluding labor cost $3,103.18 in order to get books, slides, posters, publications and the L-5 News to you. The phone bill to get the "news" to us ran $2539.89.

Please note we paid $970 to a number of outstanding artists and writers for work in the L-5 news. We pay for some-but remember, volunteerism is still the word.

We are here! The Ann Arbor L-5 Society officially came into being last March 23. Anyone in the southeastern Michigan area who is interested in joining our rapidly growing clique may write us at Box 126, Michigan Union, Ann Arbor, MI 48109.

Report from the Annual Meeting

by Carolyn Henson, Secretary, Board of Directors

At the annual meeting, after voting down a motion by Daniel Lomax that the election for the Board of Directors be invalidated, the ballots' were counted. Lomax, who, as a member of the nominating committee, counted the ballots, wanted it made clear that he did so under protest. All candidates for the Board were elected. We appreciate Vid Beldavs of Columbus, Indiana, for chairing the meeting from 2 to 3:30 p.m. (when he had to catch a plane) and Marc Boone of Ann Arbor who chaired it from 3:30 to 8 p.m. Special thanks to the folks who voted to adjourn before we starved, and our condolences go to those who gave up and walked out!

The Board of Directors now has the following members: Gordon Woodcock, Harlan Smith, and Carol Motts (new members); H. Keith Henson, Carolyn Meinel Henson, William H. Weigle, Norie Huddle, Konrad K. Dannenberg, Hon. Edward R. Finch, Jr., Leonard David, Jim Oberg, Barbara Marx Hubbard, J. Peter Vajk, Magoroh Maruyama, Jack Salmon, Phillip Parker, David M. Fradin, Romualdas Sviedries, and Mark Myron Hopkins (previous board members).

Mark D. Grover of Evanston, Illinois wrote in saying, "I have become more than a bit curious about the cryptic lines concerning recent 'major changes in the management of the Society.' For those of us who aren't able to 'see it happen' in Tucson, I think an explanation is in order."

June 11 the Society's administrator, Daniel Lomax, resigned leaving behind a badly "overcommitted" checking account and hundreds of unshipped orders.

These problems, which developed over some months, were not entirely his fault. Among other things, they stemmed from over ambitious projects (May '77 L-5 News) and procedures and personnel which could not keep up with the increasing work load. We do appreciate the good things accomplished by CDS (Daniel Lomax's company) for the Society over the last year.

Thanks to a heroic effort on the part of nineteen volunteers (see credits in the August L-5 News), a top notch secretary from Kelly Services, and loans and donations, we were able to keep any checks from bouncing, catch up on unshipped orders, and set up a new office in a month's time. The August L-5 News was the first issue put out by the new staff-in our spare time, at that!

So who's running the Society now? Every month you can check the lineup in the masthead on page 1. Membership services are handled by Doris Cooper (the Shipping Hot Line Lady) and Eileen Asher; Bill Weigle is administrative assistant, and I am editor. Who's the administrator? We're looking for a good business manager fill the slot.

Mark Grover had another question: ". . . as the L-5 News has gotten larger and slicker every month, the bylines are getting fewer and far between. There are several markedly different styles in the various articles, and I'd strongly suggest that someone take the credit (or blame) for each."

Articles without bylines are written by me using press releases, State Department telegrams, government agency notices, etc. Their style is markedly different from my bylined articles because, let's face it, "ERDA Issues National Energy R&D Plan" doesn't really get my juices flowing, whereas "NASA Nixes Algae Burgers"-to cite my favorite literary opus-gives me something to really sink my teeth into. So, next time you read a dreadfully boring article about some government contract, you know who to blame.

One article in the August L-5 News is an exception to the above rule. I guess it's really unfair to keep you in suspense about who coauthored "What to Remember When Reading A Study Report." They are Stella Calvert and Ray Sperber.

A EUROPEAN CONFERENCE ON SPACE SETTLEMENTS AND INDUSTRIES

Sponsored by the L-5 West European Branch

20th September 1977 9.15 am - 18.00

Provisional list of papers to be presented

1. "Results of Recent Studies of the Space Solar Power Concept"
   by Robert 0. Piland
   Assistant Director for Program Development
   NASA Johnson Space Center
2. "Space Production of Satellite Solar Power Stations"
   by William N. Agosto
   Electronics Engineer
   New Jersey, USA
3. "Biological Effects As A Factor Affecting A High Power Microwave Transmission-Reception System"
   by Adrian Cowderoy
   University of London
4. "Design Principles for Space Settlements"
   by Peter R. Voke
   British Aerospace, Electronic & Space Systems Division

5. "Sources of Volatile Materials for a Space Manufacturing Facility"
   by Dr. C.E. Singer
   University of London
6. "Area Requirements for Food Production on Space Colonies"
   by Dr. I. Richards
   L-5 Society (West Europe)
7. "Anchored Lunar Halo Satellites for Cis-Lunar Transportation and Communication"
   by Jerome Pearson
   USAF Flight Dynamics Laboratory
   Wright-Patterson Air Force Base, Ohio
8. "The Role of Selenostationary Orbits in Cislunar Settlements"
   by Peter R. Voke
   British Aerospace, Electronic and Space Systems Division
9. "The Role of Nonweiler Waverider Spacecraft in Exploring and Colonising the Solar System"
   by Duncan Lunan
   ASTRA

For further details write:
The Director
L-5 Society
40 Lamb Street
Kidsgrove, Stoke on Trent
England, U.K.

Philadelphia, Pennsylvania now has a meeting place for L-5 members who live in the Delaware Valley and South Jersey area.

The meetings will be every Saturday morning from 9:30 a.m. to 1 p.m. at the Central Library, Logan Square, 19th and Benjamin Franklin Parkway, Phila., Pa.

The first meeting will be 9:30 a.m., August 13 and every Saturday thereafter for at least 12 weeks before we have to rotate to another Phila. city library or can renew our lease. For further information contact:

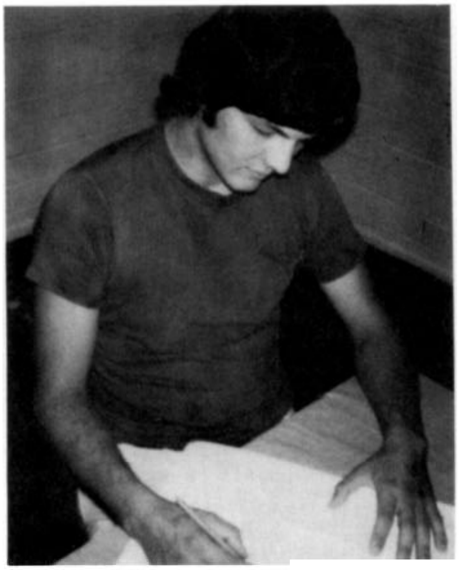
Mr. Richard W. Bowers
3059 Cedar St.
Phila.. Pa. 19134
Phone: (215) 739-7780

Volunteers this month included Howard Gluckman of Los Angeles, Neil Rest of Chicago, Marc Boone of Ann Arbor, and Tucsonans Jim Anderson, Mara Anzuina, Elizabeth Martin, Michelle Branch and Gale and Windy Henson.

You can get free room and board for your next vacation in Tucson, America's winter playground, in exchange for working a mere 12 hours per day in the L-5 office. (Remember, folks, that's only half the hours in a day!) Take advantage of this special offer today by writing:

Carolyn Henson
Director, Volunteer Labor Gang
L-5 Society
1620 N. Park
Tucson. AZ 85719

Volunteer's Notebook



My vacation. *-Marc Boone*

If I got a paying job doing this I could afford to eat better than they're feeding me. -Neil *Rest*

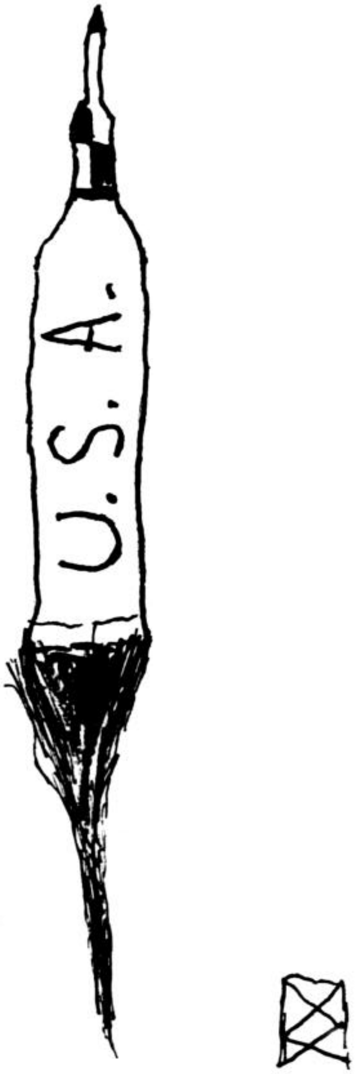
Listen to side two of Abbey Road as one piece. Here comes the Sun. -- *Jim Anderson*

In a recent letter, I said I would "put the final nails in the coffin of L-5 as a place for the colony." Keith responded with, "Can we put a little colony at L-5 just' for sentimental reasons?"

My mathematical results do, indeed, show that under the best-understood method of lunar mass transport, L-5 is a lousy place. But in response to the overwhelming public interest in L-5, I have devised an alternate approach, which may indeed permit a good case to be made for L-5. Moreover, this approach would allow us to say that L-5 is to be preferred over L-4, if that is indeed the case.

I hope to have preliminary mathematical results, pertinent to this problem, early in September; definitive results would then be available by the end of the year, after I return from a lengthy trip Stateside. So, all friends of L-5 are advised to watch closely for developments.

T.A. Heppenheimer
Heidelberg, West Germany



Up in space I want to float. If you want to float in space, call 602/622-6351.
Mara Anzuina
Age 10

BIBLIOGRAPHY UPDATE

by Conrad Schneiker

"The Safe Shuttle"
Nelson E. Brown
Technology Review, March-April 1977

If you like disaster movies, you're sure to enjoy reading about the endless number of things that could turn a routine shuttle flight into a waking nightmare. If in addition, you're planning to ride the shuttle, you'll be somewhat relieved to find out how most of these contingencies have been planned for using a "fail-operational" philosophy ("bring 'em back alive!").

"Mining Outer Space"
Michael J. Gaffey, Thomas B. McCord
Technology Review, June 1977

"Asteroids contain many of the minerals in short supply on earth. Detecting and recovering these minerals could be technically feasible and financially rewarding." This article takes a look at these technical and financial possibilities.

"An Electromagnetic 'Slingshot' For Space Propulsion"
Henry Kolm
Technology Review, June 1977

Describes the lunar mass driver, which "for all practical purposes makes the colonization of space as inevitable as was colonization of the western hemisphere."

"Gravitationally Stabilized Satellite Solar Power Stations Orbit"
V.A. Chobotov
Journal of Spacecraft & Rockets, April 1977

"A concept for a gravitationally stabilized satellite solar power station in orbit [is] described." "The principal advantages of this concept are that 1) no excessively large structural subassemblies are required and 2) passive, long-life attitude control for the array is used." "Rolling motion prevents the mutal shading of the array elements at the equinoxes."

"Plsetsk -- Russia's Top Secret Military Space Center"
James E. Oberg
Space World, March 1977

A brief article on this center and how its location was pinpointed and layout became public knowledge. This was accomplished through the efforts of a science teacher and his English grammar school students who observed ground tracks. Then a few enterprising science reporters filed requests for LANDSAT photos, specifying latitude and longitude, but omitting the country in question.

"Solar Power From Satellites"
Peter E. Glaser
Physics Today, February 1977

Discusses the SSPS proposal in detail. There is a long discussion of microwave power transmission and the environmental implications of SSPS are reviewed. For safety, the author notes that rectennas may be placed off shore and that beams will be adjusted so the "Beyond 10 km from the beam center the microwave power density would meet the LOWEST INTERNATIONAL STANDARDS for continued exposure to microwaves." (Emphasis added)

"Weightless Perfection"
Physics Bulletin, March 1977

Reports on the NASA space processing programme (which uses the Black Brant VC sounding rocket). The experiments discussed "reinforce the belief that better materials can be produced in space than on earth."

"Soviet Space Shuttle"
Spaceflight, June 1977

Reports new information on Soviet plans for a recoverable 2 stage "Kosmolyot" (spaceplane). "Serious design development appears to have begun in the early 1970's . . ." "There is, as yet, no firm indication when the Russians expect to put their spaceplane into service."

"How Do U.S. Companies View Space Industrialization?"
Arthur M. Dula
Astronautics & Aeronautics. April 1977

"This article briefly describes results from a carefully prepared questionaire on space industrialization sent to chief executive officers of 378 companies selected from among the Fortune 500 list of American industries and the Fortune 300 list of American service industries." Some results: "A majority of the respondents felt space industrialization would have a significant effect on the gross national product sometime between 1996 and 2010." "Some 30% of the respondents were aware of and interested in the possibility of solar-power satellites and communication satellites." "Many [companies] know nothing about potential profit centers, but about half that do expect to become involved in the Eighties if they may retain patent rights."

"Toward Large Space Systems"
Charles J. Daros, Robert F. Freitag, Richard L. Kline
Astronautics & Aeronautics, May 1977

Discusses potential requirements for large space structures and space construction bases.

"The Promise Of The Space Factory"
Donald M. Waltz
Technology Review, May 1977

"An enormous range of commercial products, from electronic components to medicines, could be manufactured in space. The economics looks promising, but some hard-nosed research will be needed." In the late 1980's, such common items as computer circuits, medicines and laser glass may be manufactured in space. This article looks at these and other candidate products for space manufacture, space factory requirements, and that all-important and presently "blank bottom line."

"Perspectives on Satellite Solar Power"
P.E. Glaser
Journal of Energy
March-April 1977, p. 75

P.E. Glaser originated the SSPS concept in 1968 with a pioneering paper titled "The Future of Power From the Sun." In the present article he presents a comprehensive review of SSPS concept development from that time to the present. He concludes "Since the SSPS concept was first proposed in 1968, considerable work has been done on its various aspects. It is now considered an option which deserves serious evaluation. Its potential for meeting energy demands beyond 1995 is being recognized and plans for its development are being studied. Assessments of SSPS technical and economic feasibility, environmental impacts and legal implications are being carried out by academic, industrial, and government groups in the United States and abroad. These assessments indicate that: there is increasing confidence in SSPS, technical, and economic feasibility; SSPS technology uncertainties and risks are being better defined; terrestrial solar energy developments, and near-term space construction base and advanced space transportation systems studies are supportive of SSPS development; a continuing SSPS technology development program can be economically justified on the basis of our present knowledge; and environmental impacts have not emerged as a major constraint on SSPS operation."

"Alternative Approaches to Space-Based Power Generation"
D.L. Gregory
Journal of Energy, March-April 1977, p. 85

Eight power systems (solar and nuclear) for satellite power stations are described and compared, followed by a report on their evaluation. The total cost of a complete program implementing each system is optimized and calculated. This information is then used to calculate the required ground busbar costs of SPS electric power. Four of the systems are judged viable. The net result is "that 'power from space' is not dependent upon a single power generation concept. Analyses of the exhaust emission quantities of the associated launch systems, rectenna land use, etc. indicate that the environmental impact associated with the SPS concept is extremely low. The baseline program would produce the first commercial power from space in 1996. This would be by no means an 'accelerated' program: SPS operation could probably be achieved at a much earlier date."

"The VTOVL Shuttle"
Philip Bono
Spaceflight, May 1977, p. 197

This very noteworthy letter should have been published as an article in its own right. It is prompted by the Boeing Powersat article (Spaceflight, February 1977, p. 52) reviewed here last month. The Boeing concept is based on a single-stage VTOVL rocket transport, which in turn grew out of Philip Bono's design for a similar transport using a plug aerospike engine. Two NASA patents were taken out on his behalf for the previous design. He states that "14 years have passed since the first engineering paper was publically presented to an AIAA conference in Los Angeles." In addition he coauthored a book with Ken Gatland (Frontiers of Space) which "devotes most of its discussion (and colour illustrations) to a detailed examination of the VTOVL 'Shuttle' concept." It has been translated into 5 languages. Mr. Bono notes that his concept "has met with opposition and skepticism within the US technical community" and that until recent years it was "completely ignored, even as a second (or third) generation Shuttle." He proceeds to note recent studies "requiring huge payloads in the order of 500,000 to 1,000,000 lb. have revived the VTOVL, the enormous weights of such heavy-lift single-stage devices would be virtually impracticable to land horizontally (with wings)" He adds "From the beginning the Interplanetary Society [publishers of Spaceflight] recognized the approach as at least one viable solution to the reusable launch vehicle problem." It's good to see Boeing now realizes this as well.

"Project Columbus 1992"
Brian O'Leary, The Bulletin of the Atomic Scientists, March 3, 1977, p. 4

A call is made for Project Columbus, "the name applied to the entire umbrella made possible by building the first space factory which could process lunar or asteroidal materials by 1992." Neat idea but why wait 'til '92?

"On The Feasibility Of Small Power Satellites"
K. E. Drexler, T.A. Heppehneimer
Journal of Energy, May-June 1977

The transmitting antenna of a powersat will not function correctly if scaled down. This results in two problems: building a small demonstration powersat (using the space shuttle) and feeding power into the national energy grid (which is designed for one Gw blocks of power, whereas the most economical powersat system yields a 10 Gw block). This article demonstrates that the use of a power relay satellite overcomes these obstacles.

"Will The Next War Be Fought In Space?"
Edward Hymoff
Popular Mechanics, July 1977

A sneak preview of DOD preparations for the "Star Wars" of the 1980's. Filled with discussions of suicide satellites, mine fields laid down by "mine-layer" satellites, hunter-killer satellites, decoy satellites, "dark" satellites (i.e. invisible to conventional radar) lurking in deep space (two were launched last March), and recoilless space weapons (lasers and particle beams).

"Energy From Outer Space"
Richard F. Dempewolff
Popular Mechanics, June 1977

An excellent introduction to "big booster earth launched" powersat concepts for the lay reader. Very well illustrated with some striking paintings.

The papers reviewed below are from the 1977 Princeton Space Manufacturing Facilities Conference. They will be available in hook form this October and can be ordered from:

Jerry Grey
AIAA
1290 Avenue of the Americas
New York, NY 10019

"Mass Driver Theory and History"
Frank Chilton

Presents historical highlights of linear induction and sychronous motors and an overview of their theory of operation. This paper serves as an introduction to the mass driver papers below. Of interest is the brief discussion of a coaxial mass driver geometry, potentially a factor of three times less massive than the "standard" double-sided-rectangular geometry. It is noted that "Accelerations of the order of 100 g's are easy and over 100 g's are possible if desired." In conclusion, the mass driver "promises to be extraordinarily useful for space industrialization."

"The Long Duration Exposure Facility (LDEF) -- A Test Bed for Space Technology Development"
John D. DiBattista, Lenwood G. Clark

"There are significant limitations to simulation of the space environment in laboratories." These difficulties are described. The role of the LDEF program is space technology testing is presented. It will study "the synergistic effects of space vacuum, plasma, radiation, thermal cycling, and reduced gravity.

"In situ testing in space is usually important to obtain engineering and design data on new technologies (i.e., materials [such as adhesives, seals, lubricants, thin films for solar sails], coatings, etc.) which will be necessary for the success of future NASA and DOD programs involving very large space structures which must have useful lifetimes in space of several decades."

"Space Solar Power-The Transportation Challenge"
Hubert P. Davis

The role of space transportation in the SPS concept has been identified as a potential "show stopper" based on doubts that it can operate at an acceptable cost. This paper explores the role of Shuttle derived vehicles and two stage HLLVs in SPS prototype construction and in the overall concept. I'm somewhat disappointed that single-stage-to-orbit vehicles were not discussed.

"Advanced Technology and Future Earth-To-Orbit Transportation Systems"
B.Z. Henry, C.H. Eldred

A study with the emphasis on single-stage-to-orbit vehicles has shown advanced technology to be essential for more economical earth-orbit transportation. In connection with such vehicles, a surprising result emerged. "The much cleaner recovery offered by the aircraft-type landing appears achievable at no greater cost and risk than the ballistic recovery. Accelerated technology appears to pay off in either case."

"The Space Manufacturing Facility As A Base For Exploration"
Larry Jay Friesen

Discusses the advantages of "slingshot launches" from the 2:l resonant orbit for planetary/asteroid missions as opposed to low earth orbit launches.

"Cost-Benefit Analysis of Space Manufacturing Facilities"
Mark Myron Hopkins

"This paper updates the author's previously published economic model by incorporating the results of the 1976 NASA/Ames summer study of space manufacturing facilities (SMF's) as well as other data which have recently become available. The analysis reveals that the economics of SMF's are substantially better than the favorable results found for space settlements (colonies) using this model in previous studies." In contrast to a rather common assumption, "It is found that the SMF option for producing SPS's may be less risky than building them on and launching them from earth."

"Lunar Resource Surveys From Orbit"
James Arnold

A brief summary of the Apollo findings on lunar chemical composition and how the planned lunar polar orbiter experiments will help fill in the existing gaps of knowledge by, among other things, "producing a chemical map of the entire moon."

"Lunar Resources and Their Utilization"
W.C. Phinney, D. Criswell, E. Drexler, J. Garmirian

Lunar surface materials are characterized, significant compositional differences between maria and highlands soil are discussed, a conservative processing plant design for these materials is presented and the rationale for not locating such a plant on the lunar surface is given.

"Basic Coaxial Mass Driver Reference Design"
Henry Kolm

A detailed exposition of coaxial geometry mass driver design principles with HP-67 & HP-25 program listings for performance computations. The original coaxial design was originated by the author. Its "superiority stems from the fact that inductive coupling between bucket and propulsion coils is inherently tighter, which permits more effective utilization of conductor mass, and both the bucket and guideway structures are subjected only to pure tension forces, which permit higher acceleration before structural limits are reached."

"Mass Driver Retrieval of Earth-Approaching Asteroids"
Brian O'Leary

Discusses mechanics and tradeoffs for mass driver tugs "designed to move Apollo and Amor asteroids at opportunities of low velocity increment to the vicinity of the Earth." (Apollo asteroids cross Earth's orbit, Amor asteroids approach Earth's orbit.) The author demonstrates that this source of material for high orbit use may be an order of magnitude less expensive than lunar materials. Thus "the total investment of a space manufacturing program could be reduced twofold by using asteroidal instead of lunar resources; such a program could begin several years sooner with minimal concurrent development if asteroidal search programs and mass driver development are immediately accelerated."

"Mineralogical Characterization of Asteroid Surface Materials from Reflectance Spectroscopy: A Review"

M. J. Gaffey and T.B. McCord

Opens with a helpful definition of terms "For those individuals not conversant with the terminology of planetary astronomy, remote sensing or minerology." I encourage all authors of technical articles to follow this example where appropriate in order to make the literature on space manufacturing/space habitation comprehensible to those whose area of specialization does not match the author's. The growing public interest in this field and its interdisciplinary nature make this a desirable goal. The interpretation of asteroidal spectra and the underlying theoretical basis for such interpretation is discussed at length. Indrawing out implications for space industrialization efforts, the authors conclude that "The Inner Belt, with several tens of thousands of objects to select from and with volatile-rich minerals in abundance, may prove to be the cheapest (with regard to energy) source of much of the needed raw materials." How? Solar sails "may make even relatively distant asteroidal sources competitive with Lunar surface."

'A Factory Concept For Processing And Manufacturing With Lunar Materials"

Gerald W. Driggers

"A conceptual design for an orbital factory sized to process 1.5 x 10^6 metric tons per year of raw lunar fines into 3.0 x 10^5 metric tons of manufacturing materials is presented. A conservative approach involving application of present Earth based technology leads to a design devoid of new inventions." For the system described, it is found that "By Earth based standards the individual plants and segments are not highly efficient. Taken as a whole and coupled to efficient automated assembly outside the facility, the concept is very efficient in terms of manpower, mass and volume. The key is end-to-end, raw material to finished product system integration. The realization of this type of facility may represent the next plateau of industrial development."

"Systems Analysis of a Potential Space Manufacturing Facility"

Gerald W. Driggers

"Results of a preliminary design study of the system elements comprising a manufacturing facility in earth orbit are presented. The elements discussed include cis-lunar transportation, lunar base, materials transport, factory, living facilities, construction support and energy supply. An evolutionary path of development, production and deployment is presented and step-wise interrelationships discussed." The author makes the interesting observation that "The level of detail allowed by the constraints of this study was sufficient to illustrate the intriguing potential for manufacture of products in space from lunar materials at high production rates."

1. Readers of L-5 News are encouraged to send to L-5 Society reprints of articles by them or by others relevant to space industrialization and extraterrestrial community design.
2. L-5 News will publish abstracts of relevant publications provided:
   a. An abstract of *not more than 200 words* is provided by the author or by the person sending the reprint to L-5 Society, and *is accompanied by a copy of the entire article or book.*
   b. The abstracts are subject to editing or rejection by the editor of the L-5 News.

Many literature-followers may not know what a goldmine the Government Printing Office is. They send out a free monthly bulletin of Selected Publications.

The April issue has, among a hundred other things, books on population psychology, ecosystem impacts of urbanization, and waste management technology; and a pamphlet, "What's New on the Moon?"

Just write Superintendant of Documents, U.S. Government Printing Office, Washington, D.C. 20402, to get on the mailing list.

Neil Rest
Chicago, Illinois

Time Out For Tomorrow

Norman Avery

by Conrad Schneiker

The cover of this futurism book sports a painting of O'Neill type III space colonies with glued-on reflectors. In the forword, the author says "great depth will not be given to the various ideas presented herein . . ." Unfortunately he succeeded a little too well in that respect. For example, there are just 5 pages of text (yet 7 pages of illustrations) on the topic of space colonization. This book touches on many other interesting subjects: communication, computers, lasers, energy, transportation, etc. However, just after a new and interesting item is introduced, the subject is changed. The result is a "gee whiz" book that is somewhat frustrating if you want to know some of the hows and why behind all the neat prophecies. On the plus side, this book is packed with sketches, paintings, and photographs. It is an enjoyable book to look through. I hope there will be a revised second edition with smaller print that gets more into the "guts" of its subject.

Colonies In Space

T.A. Heppenheimer.
Introduction by Ray Bradbury.
Stackpole Books $12.95

To skeptics concerned with economic and social priorities, aerospace engineer Heppenheimer has a ready reply. The space colonies which he and other scientists envision-and which may one day be on NASA's drawing boards-incorporate power satellites beaming back sufficient solar energy to ease the world energy crisis. Whatever lingering doubts may remain Heppenheimer attempts to sweep away in a rosy scenario of lushly verdant, pollution-free space colonies complete with swimming pools, movies and zero-gravity sex. But space boosterism or no, space colonies could be a not-so-distant reality, so we'd better pay attention. More than 100 photos and line drawings (eight pages in color) give a startling immediacy to vivid descriptions of space shuttles, moon and asteroid mining and manned observatories which loom in our future. *BOMC alternate, Natural History Book club alternate [June 15]*

Reprinted from *Publishers Weekly*

Even the non-space fans have something good to say about Heps book -- K.H.

Colonies In Space, by T.A. Heppenheimer is being offered by the following book clubs:

Book-of-the-Month
Natural History
Explorers
Playboy

Aesthetic Implications of the Crystal Palace Space Habitat

Marjorie L. Stuart

Review by Stella Calvert

Gerard O'Neill's 1976 Crystal Palace Space Habitat is examined by a stage magician hoping to solve the chief problem with this structure. The Crystal Palace design provides significantly more living space per unit of mass than does the Bernal Sphere; however, the Sphere does provide considerably more visual space. Marjorie Stuart, a' practicing stage magician from New York State, has spent her thoughts on optimization of visual space within the Crystal Palace design. As she says, "A magician does not care what is true. He is only interested in what appears to be true."

She recommends, for example, that roads along the circumference may well be straight, since the edge of the colony is not visible, but that the side to side roads ought to curve to avoid reminding the inhabitants at every step that theirs is an extremely small closed system. In addition, she suggests that the forest of longerons and risers be camouflaged both by hanging gardens and by pressing them into double duty as structural supports for the buildings. Also of interest is the suggestion that buildings be facaded on both sides, allowing for an alternation of residential and commercial streets and a much greater visual variety.

This paper once more proves that there *is* a need for people of all disciplines and specialties to be involved in the design of space colonies; conventional architecture may not be equal to the challenge of the space city, even as conventional fabrication techniques are too limited. However, with input from magicians, artists and poets; painters, stage designers and perhaps even smugglers, viable and beautiful cities in space can and will be designed.

Additional information on Ms. Stuart's work can be obtained from

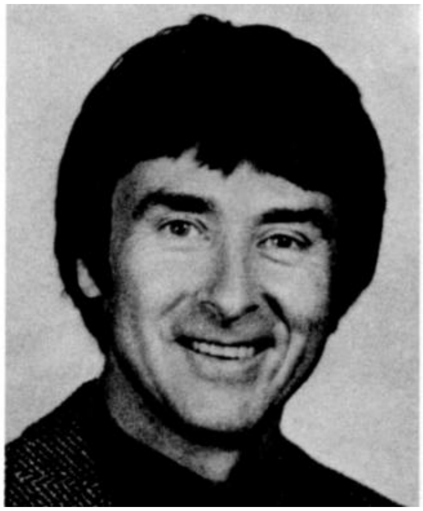
Marjorie L. Stuart, Partner
Marburger Publications
31 Westgage Blvd.
Plandome, New York 11030

L-5 Marketplace

O'NEILL FUND APPEAL

(Reprinted from O'Neill's newsletter)

by G.K. O'Neill



The first five months of 1977 have been a time of rapid progress in the work of Dr. Brian O'Leary, myself and our co-workers in many locations. Concluding a most pleasant and productive sabbatical year as Hunsaker Professor at M.I.T., in the Spring I gave there a seminar series titled "Spaceflight via Maxwell's Equations." This series went into research-monograph detail on the subject of electromagnetic mass-drivers, covering acceleration, guidance, mass-optimization and applications. The seminar-series is the basis for a technical book now in preparation.

During these months a working model of a mass-driver, with two-meter acceleration length, was built by a volunteer group at M.I.T. with the guidance of Dr. Henry Kolm and myself. The model was tested successfully at the 1977 Princeton Conference. An initial research grant to Princeton and M.I.T. was given in April by the Propulsion and Power Division of the Office of Aeronautics and Space Technology (OAST) at NASA Headquarters. A considerably larger grant, from NASA HQ in cooperation with NASA-Lewis Research Center (LeRC) is in an advanced stage of discussion for the year beginning Sept. 1977. The goal of that research program is a spaceflight-qualified mass-driver reaction engine, to be assembled in space from the Shuttle in the 1980's. Given funding, the intermediate goal will be a 10-meter, synchrotron-mode driver, in vacuum with a superconducting carrier, targeted for 1,000 gravities acceleration and a peak velocity of 1,000 kilometers/hour. The end-products of this line of research are intended to be mass-driver reaction engines able to lift 850-ton payloads from low earth orbit to lunar orbit, using surplus Shuttle external tankage as reaction mass, mass-drivers as asteroidal transfer engines, and as lunar materials launchers. One job opening in this program is expected to exist at Princeton as of Sept. '77, for a fresh Ph.D. with strong EE, Physics and Aerospace preparation,

Television crews from WGBH-NOVA, planning a one-hour special in January 1978. and from BBC-TV, planning three one-hour specials for the Spring of 1978, attended the Conference and thoroughly documented the mass-driver tests. Our keynote speaker this year was Congressman Donald Fuqua. and Ambassador Peter Jankowitsch, Chairman of the United Nations Committee on the Peaceful Uses of Outer Space, delivered an important address at the Conference. With the continued cooperation of AIAA, it is expected that the next (1979) Princeton Conference will be explicitly international in character.

During these months Dr. O'Leary, Dean Stephen Cheston of Georgetown and I have completed the assembly of the Advisory Panel for the U.S.R.A. (Universities Space Research Association) Task Group on Large Space Structures, which I chair. This advisory panel combines representation from a number of constituencies, including engineering, natural sciences, life sciences, humanities, organized labor, the electric utility industry and the investment community. The first meeting of the Panel will be held July 25-26 in California, timed for briefing on the results of the 1977 NASA Study (see below).

Dr. O'Neill's main research area is high-energy particle physics. In 1956 he invented the storage-ring technique for colliding particle beams, a method which is now the basis for nearly every new high-energy machine. His studies on the humanization of space began in 1969 as a result of undergraduate teaching at Princeton, and were first published in 1974.

He is a pilot with ratings for gliders. land aircraft and instrument flight, and as a sailplane pilot holds an International Diamond Badge in soaring. On most of his travels in connection with research and lectures he pilots a small airplane.

Dr. O'Neill was selected by the editors of Aviation Week as one of the 25 Americans who contributed most to the development of the Aerospace field in the year 1975. He is a member of the Advisory Board of the National Air and Space Museum of the Smithsonian Institution, and serves regularly on advisory boards and panels related to advanced developments in space.

To support the development of space manufacturing/space habitats in a number of ways, a non-profit corporation, the Institute of Space Studies, Inc., is being formed in Princeton, separate from the University. Its title is not yet final, and a separate announcement of the establishment of the Institute will be made within the next months.

To: G. K. O'Neill
Institute of Space Studies, Inc.
Box 82
Princeton, N. J. 08540

Enclosed is a contribution of $ ____________ to a non-profit tax-deductible institution, toward support of one year's secretarial work or equipment needs of the Princeton space-studies group, not obtainable from University or Government sources.

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Conference: The Industrialization of Space

San Francisco
October 18, 19, and 20

SELECTED PAPERS (PRELIMINARY)

(TECHNICAL ASPECTS OF LARGE SPACE STRUCTURES)
"Freedoms and Constraints in Solar Power Satellite Designs;" Sperber and Zipursky; MIT. "Automated Space Fabrication of Structural Elements;" Engler; NASA/MSFC. "A Near Term Space Demonstration for Large Structures;" Nathan; Grumman Aerospace. "Space Construction-Near-Term Initiatives;" Woodcock; Boeing. "Space Construction of Large Space Structures;" Milton; Lockheed Missiles & Space.
(HISTORICAL PRECURSORS AND ANALOGS)
"Space for People;" Sklarew; Science Applications, Inc. "Hidden Perils in Government Support of Space Activities;" Poole; Space Freeport Project. "Man and the Stars: A Summary;" Gilson; Consultant. "Governmental and Industrial Roles in Initiation of Space Industrialization;" Stine; Consultant. "Expanding NASA's Charter to Facilitate Space Utilization;" Grodzka; Lockheed Missiles. "Energy Crisis, A History Lesson;" Sviedrys; Polytechnic Institute of New York. "Two Lessons from the Past: An Analysis of Government's Role in Developing Super-Economies;" DeMandel; Consultant.
(ADVANCED TRANSPORTATION SYSTEMS)
"The Space Shuttle, Status and Utilization;" Thompson; NASA/JSC. "Advanced Launch Vehicle and Technologies;" Bell; Rockwell International. "Ground Operations and Concepts for Future Space Activities;" McCoy; NASA/KSC. "A Hybrid Chemical-Nuclear Space Freighter Concept;" Kingsbury; McGill University. "The Interim Upper Stage;" Downey; Boeing. "Solar-Electric Propulsion and Inter-Orbital Transportation;" Austin; NASA/MSFC. "Space Flight with Magnetic Acceleration;" O'Neill; Princeton University. "A Non-Synchronous Orbital Skyhook;" Moravec, Stanford University.
(ECONOMIC REALITIES)
"Space Industrialization and the Long Term Prospects for Terrestrial Civilization;" Vajk; Science Applications, Inc. "Commercial Manufacturing on a Space Station;" Geschwind; Grumman Aerospace. "The Space Power Economy;" Beldavs; Cummins Engine. "A Free Enterprise Model for the Operation of Industrial Facilities in Space;" Sanders; International Investors' Research and Technology. "Space Industrialization -- The Long Range View and the near and Intermediate Steps;" Gould; Rockwell International. "The Space Industrialization Study at Science Applications, Inc.;" Sklarew; Science Applications. "Marketing Techniques and Space Industrialization;" Stine; Consultant.
(SPACE COMMUNITY PLANNING)
"Space Community Planning on a Down-to-Earth Context;" Mack and Esdale; SRI International. "If We Can Get Along at Idaho State, We Can Get Along in Space;" Mead et al; Idaho State U. "Design Principles and Cultures;" Maruyama; University of Illinois. "Alternative Social Structures in a Vacuum;" Bluth; California State University at Northridge. "Weather or Not-Meteorology in a Space Cylinder;" Ziegler; Polytechnic Institute of NY. "Aesthetic Implications of the Crystal Palace Space Habitat;" Stuart; Consultant. "Entrepreneurial Opportunity in the Provision of Community Services in Space;" MacCallum. "Kids in Capsules -- A Children's Eye Perspective on Being Spaced Out;" Cullinan. "Public Perceptions of the Space Community Program;" Rudoff; San Jose State University. "Space Community Planning from a Viewpoint of Experience;" Heppenheimer; Max Planck Institut; "From the Hilton to the Heavens;" Cullinan; SRI.
(PSYCHO-SOCIAL AND BIOLOGICAL CONSIDERATIONS)
"A Layman Looks at Life in Space;" Damren; Consultant. "Personal Growth Education for Space Colony Inhabitants;" Cutler; Lockheed Missiles & Space. "Military Uses of Outer Space;" David; FASST. "Cultural Implications of Extraterrestrial contact and Space Colonization;" Urbanowicz; California State University at Chico. "The Psychological Effects of High Orbital Migration;" Leary; Lecturer.
(TECHNICAL ASPECTS OF SPACE HABITATION)
"Habitats in Space-An Update;" Shettler, General Motors. "Technology Requirements for Closed-Ecology Life Support Systems Applicable to Space Habitats;" Spurlock; Georgia Institute of Technology. "Magnetic Radiation Shielding for Permanent Space Habitats;" Paluszek; MIT. "Space Habitats at the Earth-Moon LaGrange Points;" Schutz; University of Texas. "Requirements of Orbiting Facilities for Industrial Space Processing;" Alvarado; GE. "Concept for a Lunar/Orbital Logistics Support Station and Training Facility;" Fedor.

(COMMUNICATIONS AND NAVIGATION)
"NAVSTAR Global Positioning System Program Overview;" Meston; Rockwell International. "The industrialization of Space;" Bekey; Aerospace Corporation. "Public Service Satellite Communications, Where We Are and Where We Are Going;" Lipke; Comsat General. "Space Industrialization: Education;" Joels; NASA/Ames. "Assembly in Space of Large Communication Structures;" Zylius and Ehrlich; Rockwell International

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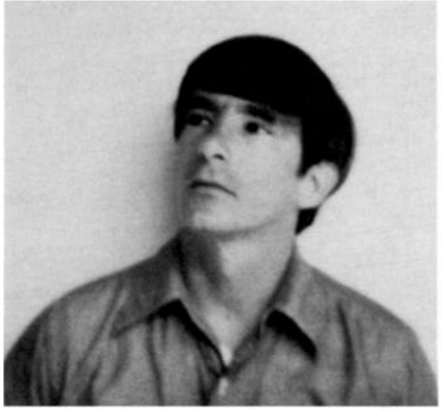
O'Neill Fund appeal (continued)

As our work has grown, though, a serious problem has grown with it. We devote practically all of our research grant money, considerably as it has grown, to materials, labor and other costs directly connected with the technical research. Departmental restrictions prevent our increasing our staff beyond one very overworked secretary, and as a result I devote considerable time to typing nearly all my own letters myself, and to other secretarial and clerical work. Possibly through the mechanism of the new Institute now being formed, I would very much like by September '77 to bring in a full-time secretarial assistant. We cannot ask government funding for such a position, and I would like to find whether there is a broad-based support for providing the necessary salary through small or larger tax-deductible contributions

I acknowledge with particular gratitude the contributions made in support of our work during the past several months by Mr. William O'Boyle and Mr. David Hannah. It is indeed a great pleasure to report so much progress, and there is every reason to believe that our cooperative effort will be equally exciting in the months ahead.



Paul Siegler

The “Industrialization of Space” will be the biggest, most exciting conference held on solar power satellites, space industries and settlements. The speakers and topics discussed will be remarkably eclectic. Organizer Siegler, a free enterprise buff, Harvard Business School graduate and founder of Earth/Space, Inc., has pulled together NASA officials, corporation executives, college professors and mavericks, all of whom are working on a constellation of space projects.

Siegler promises audience interaction with all the speakers in lengthy question and answer sessions, as well as informal get-togethers where those of us in the New Space Program can meet and get to know each other.

As anthropologist Magoroh Maruyama has observed, “As members of L-5 Society get to know one another at various conferences and meetings, it has become clear that L-5 Society has a colorful assortment of different personalities.” (Colorful Personalities, August ‘77, L-5 News.) People attending this conference can meet fascinating personalities ranging from the cultured and articulate Gerard O’Neill, the boisterous T.A. Heppenheimer (get him to sing “The High Frontier” for you!) to the legendary Tim Leary -- not to mention your beloved L-5 News editor, me. Hope to meet you there. *-Carolyn Henson*

P.S. Don’t forget to take the L-5 member’s discount when filling out your application.

The Summer 1977 *AIAA Student Journal* features -- you guessed it -- space settlements. It includes articles by Jerry Grey, Gerard O’Neill, Leonard David, Brian O’Leary, and Rusty Schweickart. Copies are available for $1.00 for members of the AIAA; $5.00 for nonmembers, from:

J. Jeffry Irons
Director of Student Programs
AIAA
1290 Avenue of the Americas
New York, N.Y. 10019

CONFERENCE TACKLES “PEOPLE PROBLEMS’

The “people problems” of space settlements will be delved into in detail for the first time in this conference. Following is the abstract for one of the papers in the Psycho-Social and Biological Considerations session:

THE PSYCHOLOGICAL EFFECTS OF HIGH ORBITAL MIGRATION

by Timothy Leary

In the 16th Century the Old World faced the challenging opportunity of colonizing a vast and rich New World.

Two psycho-social systems-which we shall call the Anglo-Celtic and the Mediterranean-set up civilizations in North America and South America respectively. The differences between these two experiments provide interesting perspectives for anticipating what will happen in the next few decades as the limitless riches of post-terrestrial space attract Old World social competition.

1. The Anglo-Celtic psycho-social model is based upon individualism, democratic rule, open communication, free mobility, plurality of lifestyle, personal growth, tolerance of difference, competition, encouragement of invention, experimentation and creativity, decentralization, distrust of military authority, private enterprise and free-market exchange.

2. The Mediterranean model (derived from Oriental and Middle-eastern philosophies) emphasized: subordination of the individual to authoritarian rule, restriction of communication (censorship), restriction of movement, controlled uniformity of life-style, discouragement of personal growth, rigid maintenance of tradition, state monopoly, distrust of the inventive experimental approach, glorification of military control, centralization. collective enterprise, obedience to bureaucracy, suppression of difference.

A brief examination of the evolution of these two social models in South and North America provides instructive suggestions for the future of Space Colonization.

The technological and economic challenges for permanent High Orbital Mini-Earths appear to have been adequately met. The future of post-terrestrial colonization now depends on resolving the software issues: mobilization of public opinion supporting the migration; economic access to resources available; political and cultural control; the psycho-social models and metaphors to guide life in the New Worlds.

It will be suggested that the best way to avoid the South Americanization of Space (i.e. the emergence of civil-service bureaucracies, military dictatorships, class struggle, centralized monopolies, imposition of standardized life-styles) is to re-examine the specific factors which led to the success of the North American model. We shall reexamine the emphasis of individuality, the open invitation to migrants from every continent, the open communication which made possible a United States-as well as a review of the obvious mistakes made by the North American pioneers.

The Space Settlement program will most gracefully harness the American imagination (and the aspirations of freedom loving people throughout the planet) if a deliberate attempt is made to recall, renew, reinvigorate and repeat the successful aspects of the Jeffersonian-Edisonian model. Among these factors are the frontier expansive spirit, the western hero-heroine, the small group seeking to live out a new vision, the need for adventure and calculated risk, the genetic imperative, the melting-pot open society mystique.

Simple and effective ways of countering centralized bureaucratic rule will also be reviewed.

more MARKETPLACE

L-5/AIAA/AAS CONFERENCE ON THE INDUSTRIALIZATION OF SPACE

PRE-REGISTRATION FORM

The following registration fees will be used at the conference.

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Three days including banquet	$50	$70	$20
Three days without banquet	$46	$60	$10
Per day	$20	$25	
Banquet only	$15	$15	$10

Special member rates apply to members of any of the sponsoring organizations. (See next page for sponsors) Membership must be verifiable.

Special student rates apply to full-time students only. Student status must be verifiable.

Special rate for spouse: $15 includes registration and banquet.

Non-members may apply $10 of the three day registration fee towards membership in the American Astronautical Society.

* * * * * *

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Because the facilities are limited in capacity, pre-register early. Send check or money order (payable to American Astronautical Society) with this form to:

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Books:

The Hunger of Eve, A Woman's Odyssey Toward the Future, Barbara Marx Hubbard Stackpole Books, Hardbound. 1976	Bl	$ 8.00
The High Frontier: Human Colonies in Space, Gerard K. O'Neill William Morrow & Co., Hardbound. 1977	B2	$ 8.00
Colonies in Space, T. A. Heppenheimer Stackpole Books, Hardbound. 1977	B3	$12.00
The Fourth Kingdom, William J. Sauber Aquari Corp., Hardbound. 1975	B4	$ 6.00
War and Space, Robert Salkeld Prentice-Hall, Inc., *Unbound copy,* 1970	B5	$ 7.00
Exopsychology, Timothy Leary Peace Press, Paperback. 1977	B6	$ 8.00
Colonies in Space, Frederic Golden Harcourt Brace Jovanovich, Hardbound. 1977	B7	$ 8.00

Back Issues:

L-5 News, Volume l:l-16, Volume 2:1-6	BI #	$ 1.00
Complete set of back issues	BIA	$22.00

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Reprints:

'Satellite Power Stations," William C. Brown, *IEEE Spectrum,* March, 1973.	Pl	$ 1.00
"Colonies in Space," *Time,* June 3, 1974.	P2	$ .37
"Colonization of Space," Richard M. Reiss. *Mercury,* July/August, 1974.	P3	$ .86
"The Colonization of Space," Gerard K. O'Neill, *Physics Today,* September, 1974.	P4	$ .93
"Lagrangia: Pioneering is Space," Gerard K. O'Neill, *Science News,* September 21, 1974	P5	$ .37
"An Orbiting Solar Power Station," *Sky and Telescope,* April, 1975	P6	$ 51
"Colonizing the Heavens," Isaac Asimov. *Saturday Review,* June 28, 1975.	P7	$ .65
"The Garden of Feasibility," Gwyneth Cravens, *Harper's Magazine,* August, 1975	P8	$ .79
"Space Colonies and Energy Supply to the Earth," Gerard K. O'Neill, *Science,* December 5, 1975	P9	$ .65
"Wireless Power Transmission," John F. Mason, *Electronic Design,* December 6, 1975	P10	$ .44
"Colonies in Space," Ron Chernow, *Smithsonian,* February, 1976	Pll	$ .86
"Moon Mines, Space Factories, and Colony L-5," Michael Guillen, *Science News,* August 21, 1976	P12	$ .44
"Engineering a Space Manufacturing Center," Gerard K. O'Neill, *Astronautics and Aeronautics,* October, 1976	P13	$ 1.00
"The Impact of Space Colonization on World Dynamics," J. Peter Vajk, *Technological Forecasting and Social Change,* 1976	P14	$ 2.38
Complete set of reprinted articles	CP15	$11.25

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Space Events Recordings

Good quality audio recordings of events concerning space industrialization and space settlements are now available through: *Dawntreader, 3754 Maplewood, Los Angeles, Ca. 90066.*

"1977 NASA/Ames Summer Study Technical Briefing and Press Conference." Unedited, 4.5 hours (3 at 90 minutes), $50.00; edited, 1 hour (1, 60 minutes), $12.00.

FINAL BRIEFING (CONDENSED) SYNOPSIS

INTRODUCTION: John Billingham introduces Gerard O'Neill.

OVERVIEW: Gerard O'Neill

REGENERATIVE LIFE SUPPORT: Jack Spurlock. Definition, partial vs. complete systems, options in complete systems, directions for research/conclusions.

HABITAT DESIGN: John Shettler. Near term possibilities, Space Gateway "Corporation" timetable, conclusions. Ed Bock: long term possibilities, additional environmental factors, earth normal conditions vs. space conclusions, recommendations for research. END SIDE ONE

MASS DRIVERS: Gerard O'Neill. Definition, description of lunar mass driver, R&D program, cost, conclusions.

ASTEROID RESOURCES: Michael Gaffey. Definition and number of near earth, composition, recommendations. Brian O'Leary: conclusions.

NONTERRESTRIAL EXTRACTION: Ted Bunch. Kinds of lunar ores, byproducts, mining processes. Dayeni Rae: conclusion. David Criswell: conclusion.

PANEL DISCUSSION: John Shettler. Psychological impact of habitat. Gerard O'Neill: need for broad base public support. Gerard O'Neill, Stanley Sadin: possible other applications.

"California Space Day." Unedited, 6 hours (6 at 60 minutes), $50.00; edited 1.5 hours (1, 90 minutes), $12.00.

20% of gross sales will be donated to the L-5 Society.

All cassettes will be high quality Dolby encoded. Please specify if Dolby NR not desired. All shipments will be sent first class or UPS. For reel to reel please add 50% to list price.

WANTED: Back issues 1:13, 2:1, and 2:2 in good condition. Please send price to M. Mahaffey, 118 Colorado Dyess AFB, Texas 79607.

"Life Beyond Earth" Course

A study of the possibilities of human -- and non-human -- life in the universe outside the confines of our planet will be the topic of a nine-evening continuing education course this fall sponsored by University Extension at the University of California, San Diego.

Titled "Life Beyond Earth," the course will be held 7-10 p.m. Thursdays, Sept. 29 - Dec. 1 in the Lecture Hall of the Reuben H. Fleet Space Theatre and Science Center, in Balboa Park, San Diego. The fee is $61.

Instructor Frank Mortyn, a science writer and lecturer, notes that even now the cosmos is being probed both by human explorers and by ingenious devices invented to search for evidence of life in outer space. In his University Extension course, Mortyn will discuss the implications of this search for the human future, what we already know about the conditions for life in space, how radio contact can be established, what forms aliens may take, and space colonies in orbit around the earth.

For information on course enrollment, call University Extension at UC San Diego at (714) 452-3400 and request that an "Explore" catalog of courses be mailed free of charge.

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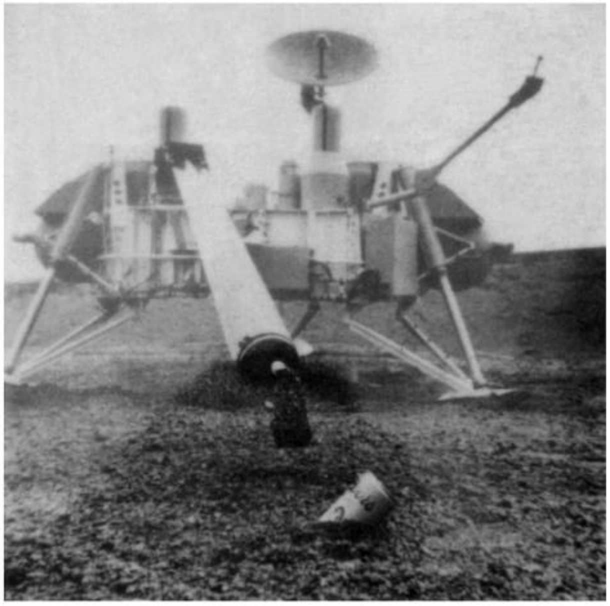
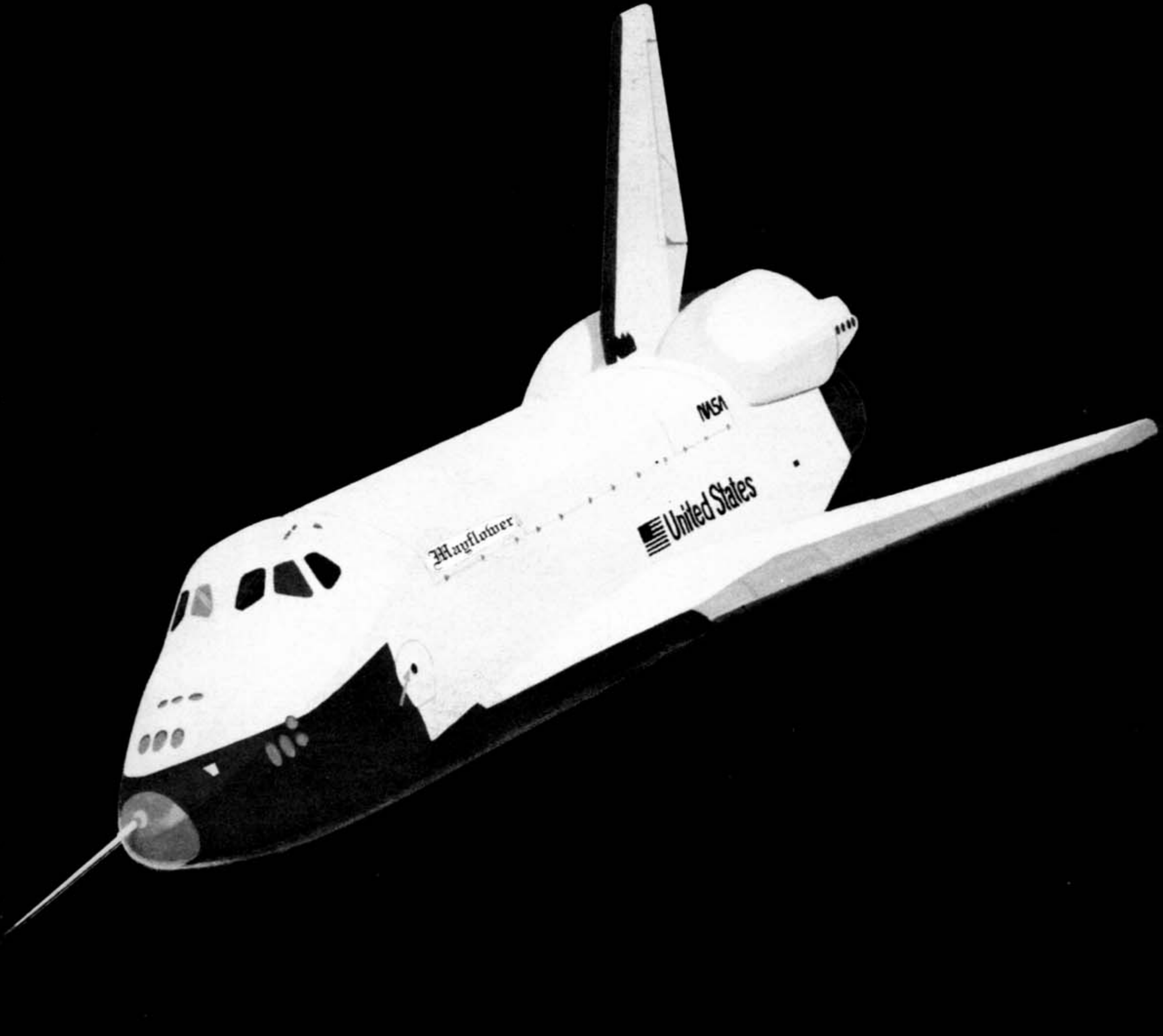


(Courtesy our Martian correspondent)

L5 NEWS

OCTOBER 1977



L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 2 NUMBER 10 OCTOBER 1977

In this issue:

1 **A Conversation Between Rusty Schweickart and Norie Huddle.** *What do a NASA astronaut and an environmental activist have in common?*

4 **NASA/USSR Cooperation Pact Signed**

6 **German Company Blasts Into Space Age.** *Theo Pirard reports on a West German private company whose "space truck" may revolutionize space freight transport.*

7 **Saito Calls for Japanese Space Colonies**

8 **The Retainable Expendable.** *Leonard David reports.*

OMB Weighs NASA Budget Cut

Schmidt Calls for "Starlaws" *An astronaut turned lawmaker considers the implications of space industries.*

9 **NASA: Priming the Pump** *by Kenneth McCormick.*

Impatient White House Rejects Proposed Solar Power Satellites. *Columnist Jack Anderson reports.*

11 **So You Want to Lobby?** *Marc Boone and Carolyn Henson provide tips for would be lobbyists.*

14 **L-5 and the Jewish Community** *Bruce Friedman hits the ethnic circuit.*

16 **A Land of Milk and Honey?** *Not if the bees can't find their way home, according to Magoroh Maruyama.*

17 **Space Shuttle: Who Can Go?** *Carolyn Henson learns that almost anyone can!*

18 **Sports In Space.** *Excerpts from Gerard O'Neill's* High Frontier *shows us there may be some frivolous reasons to go into space, as well.*

19 **Science Faction Bookshelf** *by Robert Anton Wilson*

20 **Entertainment**

21 **Is There a Mayflower in Your Future?** *Our cover story -- did you know shuttle orbiter 102, the first to fly in space (scheduled for 1979) hasn't been named yet? George Koopman hopes to christen her "Mayflower."*

Carolyn Henson, Editor

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A Conversation Between Rusty Schweickart and Norie Huddle

by Norie Huddle

NORIE: I'd like to ask what effect the experience of going into space had personally on you, on your consciousness or worldview?

RUSTY: Norie, I have a tough time with your question. Everybody who has any sensitivity or association with philosophy, Eastern thought, the wholistic view, or such things, is interested in what happened to astronauts when they go into space and return. They're interested because Buzz Aldrin came back and had a problem with alcohol, divorced his wife, and went through a whole bunch of problems and became a member of Alcoholics Anonymous-or whatever. Anyway, he was an admitted alcoholic and has made almost a profession of confessing before the public the evils of alcohol and the effects that the program had on him.

Jim Irwin started a whole movement called High Flight. He's an evangelistic preacher and basically ascribes a good bit of his commitment to go into that field on his experience during Apollo 15 and walking on the moon, thinking about and realizing the hand of God.

Al Worden has written books of poetry which quite obviously express a profound and deep-seated effect of the experience of going into space. I've done a lot of things, talked about a lot of things . . . which indicate the same kind of effect. Ed Mitchell started the Institute of Noetic Sciences and went into ESP. There have been enough evidences of change of character among the astronauts that the public, and especially people who are sensitive to it, recognize that something is going on with these people.

Quite frankly, what this results in is an absolute deluge of people asking exactly the question that you asked now, to the point where you get absolutely sick of it and want nothing more than to *deny the* whole thing! You want to shut it off because it is so utterly demanding. And' everyone-and I hate to do this to someone-but basically everybody asks the same question and is looking for magical answers from other people's experience to solve their problems.

NORIE: I think my reasons are a bit different, if I may explain. I've done quite a bit of reading about the whole space concept and I was also up at the UN Habitat Conference on behalf of the L-5 Society this past year. I came away from that and wrote a fairly extensive report on how I felt about the whole space program. Basically, you see, I am an "appropriate technologist" at heart. And yet, some part of me says that this whole space development concept is also appropriate technology . . . just that it happens to be at the high technological end of the spectrum . . . that true appropriate technology must embrace the whole length of the spectrum, from small to big.

RUSTY: "Appropriate" does not necessarily imply, "chop down a tree and build it yourself."

NORIE: Bight. Anyway, what I've been trying to do is look for the common denominator, the thread that flows through all our problems. We talk about technology solving all our problems. I've been looking at the various elements of what Barbara Hubbard calls the "evolutionary edge" of different research and development going on in the United States-and elsewhere-today. For example, there's a lot of work being done on life extension, or intelligence increase and, of course, the whole space program, which has many different aspects being developed. These offer some tremendous opportunities and changes in life as a whole. However, in all of these, it seems to me that we must get it together on an individual level, in other words, become more wholly integrated, first with ourselves and then with others and with the biosphere, and with the "flow of life" or God, or whatever you choose to call it.

If we don't do this, then we're not solving any of our basic problems. Sure, we may solve problems on a technological level, but unless we have an appreciation of the whole and the nature of reality, then we will be overlooking something and simply creating five more new problems in the process of solving that first one.

For example, if we go out into space and do things in the way they seem to be going now, it seems that we would just create an extension of the arms race out there in space. This is one thing. It seems too, for another, that in the future we could look forward to the sort of thing that we had in the creation of the United States: British colonies first, which then fought England and broke away. There are all kinds of scenarios you can create about what might

To maintain astronaut status Schweickart regularly flies a NASA T-38 high-performance jet. Meantime, with the Space Program slow-down, he flies a desk at Washington NASA Headquarters as Director of User Affairs, Office of Applications.

happen in space . . . both happy ones and grim ones.

But it seems to me that it basically comes down to the consciousness of the individuals involved. So, for that reason, I’m extremely interested in what happens to individuals who go out in space. What happens when you look back and see the living Earth floating out in that void.

RUSTY: Let me say this. First, I did this tape recording (hands me a tape). Well, I have talked about this, as I implied a moment ago, on many occasions. In some cases with modest success, whereas others were absolutely rip-roaring flops, and on rare occasions, done very well. Luckily -- and there may or may not be any coincidences in the world -- the time when this tape was made, I happened to do it the best.

NORIE: Was it at Lindisfarne?

RUSTY: Right. In 1974. I don’t know if you have this tape, but I can loan it to you, and people interested can get hold of it through Lindisfarne Association, Box 1395, Southampton, New York 11968. There’s no question at all that everything came together for me at that point. That was the best presentation of that total experience as a human being.

NORIE: I’m curious what you feel is the most exciting aspect of space development at this time.

RUSTY: I guess that depends on what time-frame you want to talk about, Norie.

NORIE: Let’s start with the long time-frame.

RUSTY: OK, it is the relationship between the environment of space, this new environment, and the long-term evolution of the life force or consciousness, or, if you want to be “chauvinistic,” of humanity; or, if you want to be religious, of God, the evolution of these as we move out into the universe.

I think that’s what we’re doing, without anybody here in these buildings at NASA thinking about it or being aware of it or agreeing with it, or being dedicated to it. I mean absolutely totally separate from what in my mind is a rather major milestone of “key event” in terms of the development of life or intelligence and its movement through the physical universe. What we’re doing-and what Gerry O’Neill is doing-on a day-today basis, has very pragmatic, practical, utilitarian, political and other ramifications, justifications, motivations and all the rest of the -ations. But what is really happening, taking that long-term view of life (whether it is a specialized bacterium that exists only in the left ventricle of the leopard frog, or whether it’s a slime mold, or whether it’s humanity), it can survive -- and move and evolve into more and more complex organisms.

This is the kind of evolutionary process about which Julian Huxley wrote and Teillard de Chardin wrote so eloquently. This is happening. And in this particular case, this transition, this really major change, this “symbiotic’‘-although this may not be quite the right description of the balance-relationship between man and machine, has evolved to a point where the machine part of it is allowing us to live now in an environment in which it never has been possible to live before-that is, the environment of the space vacuum. And that opens up opportunities for the evolution of life and progression of this evolutionary manifestation throughout the universe.

The Earth has been a womb for the development and evolution of intelligence, and I think that it is undergoing a very basic and radical change now. That is not a motivation-that is just an observation. I think you have to be very, very careful talking about things of this kind because people turn it into religion and it becomes a purpose instead of an “awesome observation.”

NORIE: That seems like a very important distinction.

RUSTY: It is. It is a *crucial* distinction. And, as I think I indicated the other day, one of my problems with the L-5 Society is that it seems too many of the people in it (although I recognize it is a group with a diverse membership, too) have grabbed onto this aspect as a sort of new religion. I don’t want to be unfair to those who don’t feel this way, but there seems to be a tendency for needing a “god” who justifies “what I want to do” as a member of this group. And it becomes a religious thing. And I think that element, where it moves away from awe and becomes a “purpose” is a shadow side of religion that makes me very uncomfortable. Whether it is in the form of space religion, or traditional God religion, or communism, or what have you. I don’t care what it is.

NORIE: In other words, using that as a religion, or a goal of one’s life and behavior, it could justify a whole lot of very unpleasant things to the true believers?

RUSTY: That’s exactly right. And if there is one thing that we need to understand-and this takes me back to an earlier point in the conversation-in terms of dealing with O’Neill’s space colony concept, any of this stuff, is that the circle of yin-yang exists in all things. There is a shadow and a light side of every element of creation and whether that is war-which people love to label “black” and not “white,” or whether it is space colonies, which devotees love to paint “white” and not “black,” both are wrong.

I mean, you can condemn the nuclear bomb, and certainly to the extent that it is used and kills people, it is negative, black, or an anti-life thing. But the fact of the matter is that if you look at theevolution of weapons, it is not at all clear that we would be at the point we are today if it hadn’t been for these weapons. Such things as concern for the developing nations, equality, poverty on the global scale, feeding people . . . all kinds of things.

We are interested in higher things in some sense because we do have this deterrent standoff. We have developed weapons against which basically there is no defense. I hope we don’t find a defense against nuclear weapons because by having this kind of parity, we have not had nuclear war. People are vulnerable and they recognize this fact.

One of the things that fascinates me about this space debate is people like John Holt, who in my mind is inexcusably shortsighted, even paranoid. He has religion, but on the other side from the L-5ers. I am very nervous about Holt. I admire the guy as an educator and it upsets me that he is so terribly unbalanced when it comes to something like this. True, the advocates of space don’t point out the shadow side, and also true to a more limited extent, it is because some of them aren’t sensitive enough to see it or acknowledge it.

NORIE: I think it is more that they are trying to sell a product. It you’re selling cars, you don’t point out that it will be obsolete in 3-4 years, or that you might well have an accident with it.

About the author: Norie Huddle is the author of **Island of Dreams,** a book on the pollution crisis in Japan. She is co-coordinator of **Mobilization for Survival,** a group opposing nuclear proliferation.

Who Is John Holt?

. . . and why does Rusty Schweickart think he's paranoid?

The following is an excerpt from a long letter by John Holt to Stewart Brand dated April 20, 1976. Mr. Holt sent a copy of this letter to MIT L-5 reporter Jonah Garbus.

There are many respects in which the Space Colonies proposal as put forward by O'Neill reminds me of the war in Vietnam. One in particular is relevant here. It's hard to remember now, but the people who planned the war in Vietnam, the proverbial Best and Brightest, were idealists. They meant to do good. And they had the modern vanity, or *hubris,* that if we mix good intentions with sufficient technical "know-how" and sufficient money, we are bound to come out with good results. Take a handful of experts who mean well, give them enough money to work with, and things are bound to come out OK. We have now found out this isn't true. The same defects of character, intelligence, and imagination that led those guys to think of the war in Vietnam in the first place, *guaranteed* that they would not be able to fight it realistically or effectively, or to learn from their experiences there, or to make a rational decision to leave. The flaws in O'Neill's character guarantee that he will make a mess of the space project if he gets enough money to work seriously on it.

The fact of the matter is, if the Space Colonies or Space Exploration research is to proceed, it can probably only be under someone quite a lot like Wendell Berry, someone with a good deal of anguish, a sense of tragedy in him. I can't right at the moment imagine why such a person would undertake such a work, but that is the sort of person you would be looking for, not the Smiling Salesmen we see happily testifying before Congress, absolutely impervious to doubt, difficulty, or danger. It seems an absolutely certain thing to me that if O'Neill is given his big checkbook, he will proceed far too recklessly, and that when this causes accidents and death, that he will lie to cover it up. Like all snow job artists, he will be easy to snow, and the program will be absolutely shot through with corruption-again, rather like Vietnam, where the people lower down the line soon discovered there was no use taking the truth to the people at the top because they didn't want to hear it.

John Holt is a teacher and author of numerous books, most recently Instead of Education: Ways to Help People Do Things Better *(E. P. Dutton, 1976). At present, Mr. Holt is at work on what he describes as a "musical autobiography."*

RUSTY: That's right. People who sell cars don't go around showing pictures of people wrapped around bridges or trees or banging into one another, or blood all over the streets. However, part of it is that the guy who sells the cars assumes that the customer is aware of those realities. And it is in somewhat the same way the NASA is charged with the development of the use of space. And you're not going to develop the use of space by talking about the fact that, yes, if you develop high power lasers, you can put them in orbit and point them at the ground, and maybe-although technically I'm not sure that it's even possible-do damage on the ground. I mean, the atmosphere does get in the way.

NORIE: The other day when you and Tim (Leary) were talking at the National Space Institute conference, I felt a bit somewhat uncomfortable with one of the exchanges that went on right at the end. It had to do with strong statements by each of you that you felt the whole space program should be carried out by the United States. I am a very strong advocate of an international and cooperative effort.

RUSTY: Let me short-circuit this. You needn't worry. The fact of the matter is -- and I am sure the same is true with Tim -- we may have been making a lot of assumptions of which you might not have been aware.

I've been in this game long enough that I know two things: first, real international cooperation depends on individuals and not on the system; and second, if you want real international cooperation, you actually start to do things and open it up purposely to cooperative international efforts. If you go the other way-that is to say, we only start things when we, have agreed to international efforts-then *nothing* happens. You just have debating groups and nothing in the world goes on.

The model I think works well is the model we have used in NASA. We have a kind of unique charter as a Federal independent agency in that we are given authority in our charter to establish cooperative ventures and programs with other nations without going through the State Department.

NORIE: That's very interesting. Have you done this?

RUSTY: Oh yes! Now, I don't want to overstate this because there are lots of good people in the State Department, but if you take the State Department as an institution, we have basically dragged the State Department along in lots of our international activities. I'm just absolutely delighted with the degree of international cooperation that we have in our NASA program. We've got lots of things going there.

For example, we are developing -- and have flown, since 1972 -- resource satellites which make beautiful pictures of the Earth and which also contain very valuable information about the surface of the Earth . . . about the state of the wheat crop in Russia or China, or assessing the total volume of forests in the developing world, or the location of unknown shoals in shallow seas which are a danger to shipping. . . there's a tremendous amount of valuable economic information contained in those pictures.

NORIE: Are these available to anyone?

RUSTY: That's the point. These are United States satellites, done with the United States taxpayers' money, but we are a global citizen and we have a very specific and hard and fast policy that everyone of those images is open to everyone for, frankly, less than the cost of of reproduction. So the data center in Sioux Falls, South Dakota, literally sells those satellite images now to . . . I'd make a guess between 100 and 200 nations. . . including Russia directly and China indirectly through an intermediary.

NORIE: Going back to the discussion between you and Timothy, then you were just saying that our history as a nation is of people who take off and do new things, the so-called "pioneer spirit?"

RUSTY: I'm saying that the United States is the institutional location of the place in which there has evolved the highest level of sensitivity to the environment, to the development of technology in a form that is useful to people. We took off, after the industrial revolution because of our own wealth in natural resources and the basic nature of the American character (which goes along with the types of people who immigrated here). And it's the kinds of people who came to a frontier that characterized and still characterizes America. We're a group of doers, not a group of people who sit around in endless debates. That's dangerous in a way. There's a good side and a bad side to that.

NORIE: The yin-yang again?

RUSTY: Right. But this a fact. And as a result, we have ended up ahead of the rest of the world in terms, first, of just rampant development of physical and material systems. And because of that, we're the first to see the limitations of that mode.

In the '50's and the '60's, it became quite apparent, and those realizations are now being reflected in the '70s. The limitations of unrestricted technology are pretty clear to all of us and so we're a good bit more careful.

But if you look at the developing countries, the same ones that are complaining about the disparity between them and the West, they're the ones who are demanding the technology. And with very little judgment about what, in the long range, is good and bad.

NORIE: Rusty, I'd like to point out another side of their feelings of those in developing countries, a side which I quite empathize with. That is, they see us as a country whose population is about 6% of the world's people, but we are consuming well over 30% of the world's resources. They see their getting higher technology as a chance to close the gap.

RUSTY: You have to be careful when you estimate consumption. We do have high consumption, but you have to subtract out of that consumption the stuff that goes back abroad in the form of foreign aid and products.

NORIE: But United States corporations make considerable profit on those products and are busy building and expanding markets in those countries.

RUSTY: Oh, sure. As I say, there is high consumption, but I feel it's important to remember that not all the natural resources we handle are consumed here.

NORIE: Sure. I think what we see, however, is that the United States-and probably most countries in her position would do the same-wants to have control of the purse strings, of the financial arrangements.

RUSTY: Yes. And, in fact, other countries with resources are trying to get control. The OPEC nations are an excellent example of this.

NORIE: I think it is important to remember here that many of those who engineered this OPEC thing, were trained in our very own Harvard Business School.

RUSTY: Sure.

NORIE: But even if other countries would do the same thing, we are doing it because of our position as a sort of

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NASA/USSR Cooperation Pact Signed

NASA and the USSR Academy of Sciences has agreed on further cooperation in manned space flight. The agreement was signed May 6, 1977, by Dr. Alan M. Lovelace, then Acting Administrator of NASA, and May 11, by Anatoly P. Aleksandrov, the President of the Academy of Sciences of the Soviet Union.

The agreement is designed to provide continuity of the joint technical, scientific and operational capability developed through the highly successful Apollo Soyuz rendezvous and docking mission conducted in July 1975. Three joint working groups will prepare recommendations for two new programs, one dealing with orbital human flight activities and the other with a possible international space station.

The first working group will begin studies soon on scientific and applications programs that may be conducted in joint operations of the American Space Shuttle and the Soviet Salyut space station in the early 1980's. A second working group simultaneously will develop plans for these joint operations. The two groups will seek to define projects that might benefit from the flexible delivery capability and large capability for longer stay-time in orbit represented by the Soviet Salyut. The emphasis will be on a "science first" program which will take advantage of these capabilities and fully justify the contemplated joint operation.

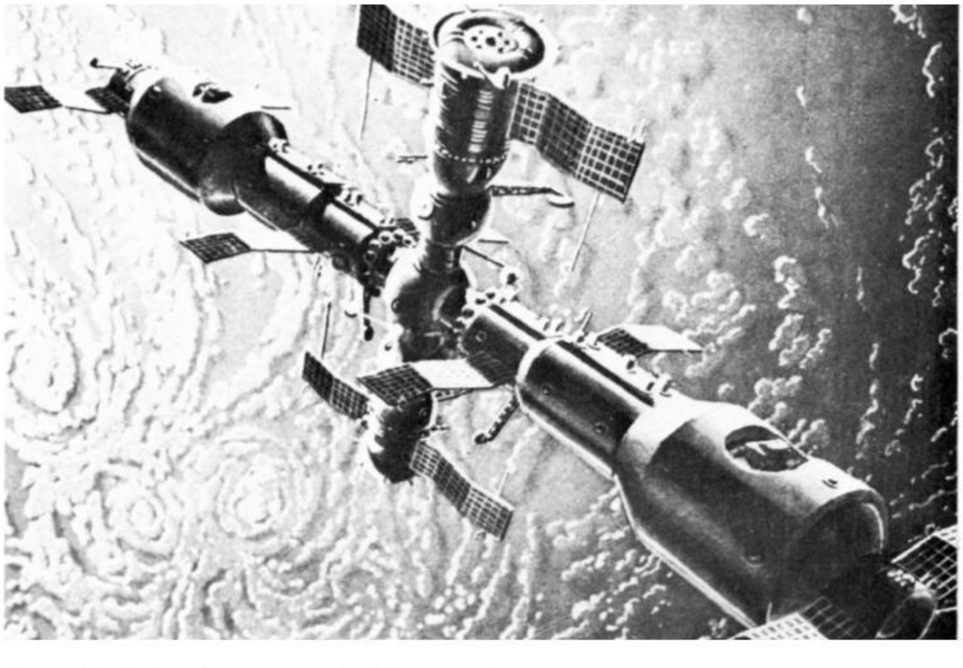
Studies of the Shuttle/Salyut program should be completed within 18 to 24 months, and should produce recommendations for consideration by both sides.

The agreement also established a third joint working group whose task will be to conduct a series of phased studies of an international space platform, or station. If such studies establish a consensus on the objectives of future space stations, further studies would be undertaken to explore possible agreement on their conceptual design.

Neither side is committed to steps beyond the initial studies and each reserves the right to proceed with its independent national space-station interests. The agreement does, however, establish the possibility that the two sides may be able to combine their space station interests to some degree, thereby offering potential economies and efficiencies.

The full text of the agreement follows.

"In accordance with the Agreement on Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes between the USSR and the USA, dated May 24, 1972, and taking into account the results of discussions held in Washington, October 19-22, 1976, between the delegation of the USSR Academy of Sciences, headed by the Chairman of the Intercosmos Academician B. N. Petrov, and the Delegation of the National Aeronautics and Space Administration of the USA, headed by the NASA Deputy Administrator, Dr. A.M. Lovelace, the Academy of Sciences and NASA agree to undertake the following steps for further development of cooperation between the USSR and USA in the exploration and use of outer space for peaceful purposes."



Proposed Soviet space base, constructed utilizing two Salut space stations.

"whipping boy."

RUSTY: Which isn't to say that we're better than anyone else, we just happen to be out front in this. And this has come about for a variety of historical reasons. So we are foremost in the exploitation of technology, and we see both the limitations of it and the opportunities and we have a responsibility to use and direct this talent or position to good end.

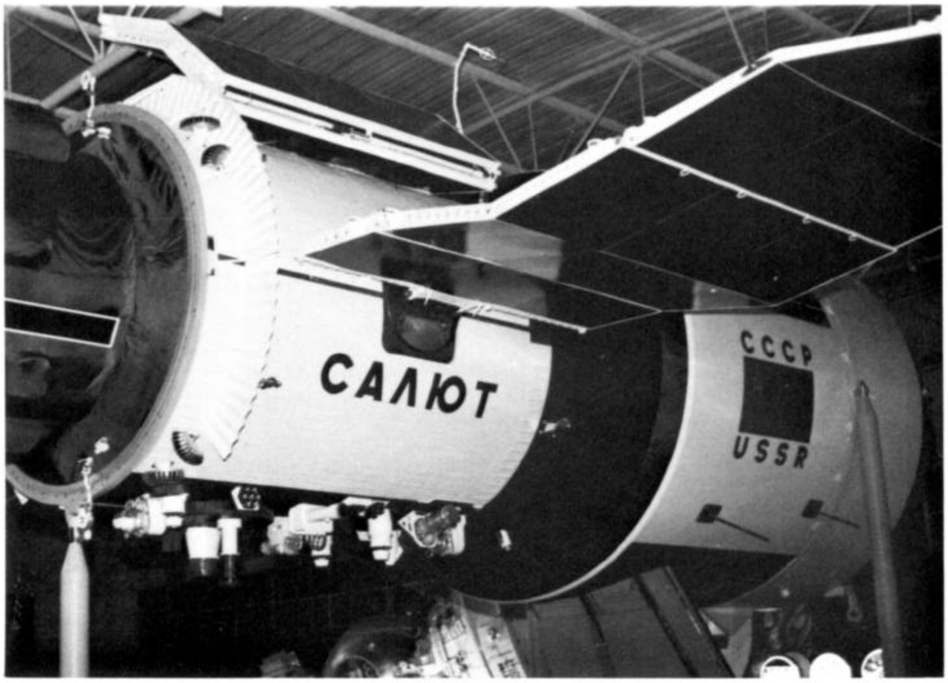
NORIE: What are some of the reasons people give you for opposing the space colonies project?

RUSTY: One of the big objections I've run into is that just about the time we're developing an environmental consciousness around the planet, as having to care for our nest, along comes another frontier, and we go right back into the cowboy-frontier mentally. And, boy, this is a strong gut reaction. And in fact, I was talking recently to Dr. Fletcher about just this thing. It is tied up in the word frontier. It is -- it is a space frontier.

The problem is that people look at a frontier as a Frontier: Put a bag over its head and every frontier is identical. What a bunch of garbage! To me the interesting thing about this is that the frontier in space, embodied in the space colony, is one in which the interactions between humans and their environment is so much more sensitive and interactive and less tolerant of irresponsibility than it is on the whole surface of the Earth. We are going to learn about how to relate to the Earth and our own natural environment here by looking seriously at space colony ecologies. It is an incredible learning tool.

So that frontier is totally the opposite from the usual concept of frontier. In fact, in the winter issue of the Coevolution Quarterly, there is an article where George Woodwell and Dan Botkin and John and Nancy Todd and Lynn Margulis and Juan Oro and a lot of other ecologists, and me, as an interloper sitting there, have been talking about space colony ecologies. And after talking about it from a space colony point of view, people begin to realize that the basic nature of that challenge, from a professional ecologist's point of view, that the kind of understanding of ecological or life systems necessary to enable one to move on seriously with some concept of space colonies, is going to serve as a focal point for much broader understanding of our own Earth ecology. It is a very interesting thing to watch people realize this. The article in the Coevolution Quarterly serves notice that the community has to get serious in lookingat the feasibility of a closed space ecology.

NORIE: To shift again, and, I'm sorry but it means going back to the whole consciousness question again, have the American and Russian astronauts had any contact, and if so, is there any indication that they have also undergone the same kind of consciousness changes?



Salut space station (photo courtesy Theo Piraud).

RUSTY: To answer this briefly, the answer is no. Nobody has communicated that well yet because of the language barrier. Some of the astronauts have studied Russian, but it is a long way from being adequate for deep philosophical questions. And the same for their speaking English. We can get along, in terms of getting our jobs done. But in terms of getting to know one another at that level, that has not happened. Now, there have been intimations that there is that interest, but it is very, very tenuous and, to my knowledge, it has not been pursued.

NORIE: I'd like your comment on how do you think that a group like the L-5 Society might better relate to and have a better impact on the whole course of space development?

RUSTY: I guess I would see the primary contribution of the L-5 Society as being able to communicate with younger people who, for one reason or another, have written off all agencies like NASA and all activities like space development as being thoroughly a negative kind of thing.

For the student population, the L-5 Society probably can break through those kinds of barriers better than something like NASA as an institution can-or even a guy like O'Neill, who, for all of his brilliance, is not that good at communicating with a certain group of people. He is great with people who are already technology-oriented. But I don't think he's that effective with those who are not.

NORIE: What I hear you saying then, is that L-5 Society can do a PR job?

RUSTY: (pause) Well, that is certainly what I said. Now, I guess the question is whether I think that is all L-5 can do. Let me be totally frank, Norie. I don't think it makes any difference at all what I think about the L-5 Society. I think they should do what they think is responsible as a group.

Nevertheless as I said earlier in the discussion, I really am nervous about the tendency toward the true believer in the L-5 Society. And, if a group which is really fanatical about something really starts pushing it, they can really do a lot of harm.

Now let me say that on the other hand -- as I discussed with Stuart and he printed in the Coevolution Quarterly a couple issues back -- to me, one of the best things in the world that could happen is that a lot of energy from society outside of the government and outside of the whole institutional setup deal with and recognize the space colony question/challenge/opportunity as something that belongs with the people and not something that belongs with the government or NASA. Whether that's individual courses in colleges, whether that's individual colleges, people, organizations like the L-5 Society, an offshoot of the Star-Trekkies . . . or whatever . . . in fact, the more the merrier.

There is such a host of things which need serious looking at, and O'Neill doesn't need to run it all, either. Lots of people can do lots of things. NASA shouldn't run it, O'Neill shouldn't run it, everyone should be encouraged to contribute to it. The task belongs to the public and people should take the task seriously. •

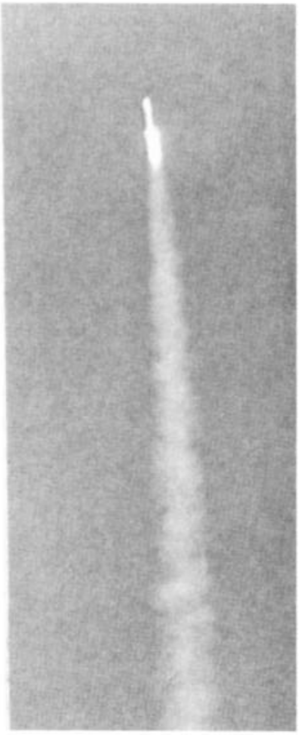
German Company Blasts Into Space Age

by Theo Pirard
European correspondent, Belgium

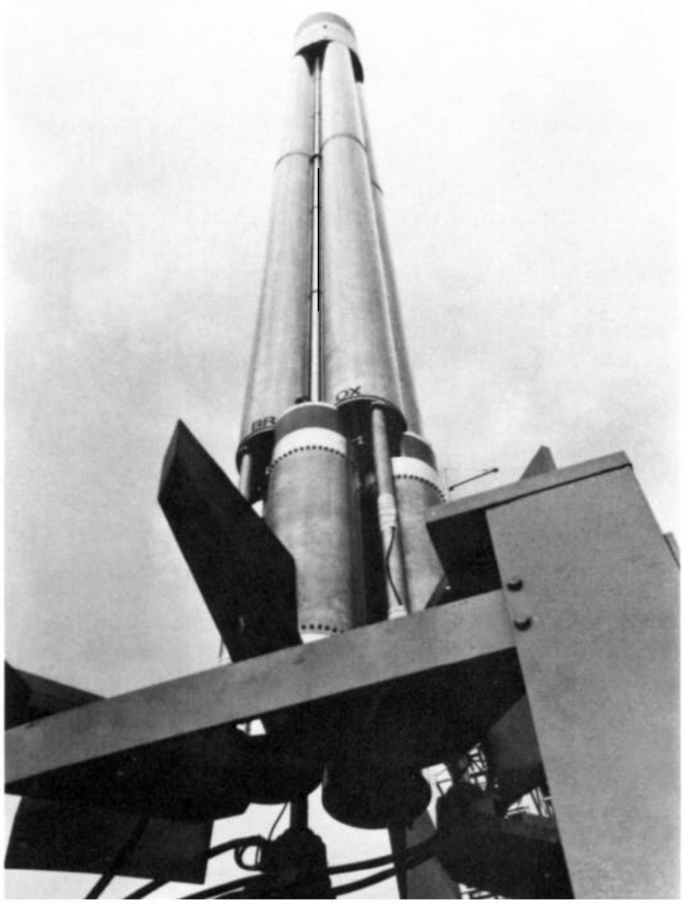
OTRAG or "Orbital Transport-und Raketen-Aktiengesellschaft" is a private society, created in West-Germany, which is making proposals for launching geostationary or heavy payloads with a modular launch vehicle. They project launch costs cheaper than the NASA space shuttle! OTRAG is working on the development of these standardized modules which will be used for the assembly of its "space truck."

On May 17, 1977, the first modular rocket, developed by OTRAG, was successfully launched from a rustic launch pad, established in the South-Eastern territory of Zaire. It was the first German launch of a large rocket since the IInd World War and the V-2 missiles. The OTRAG vehicle was an assembly of four "pipe" tanks and of four ablative motors, was 9 m long, weighed 2.5 tons and the 4 clustered engines of 3 tons thrust each gave a total thrust of 12 tons. With only partially filled tanks, the OTRAG rocket reached an altitude of more than 10,000 m.

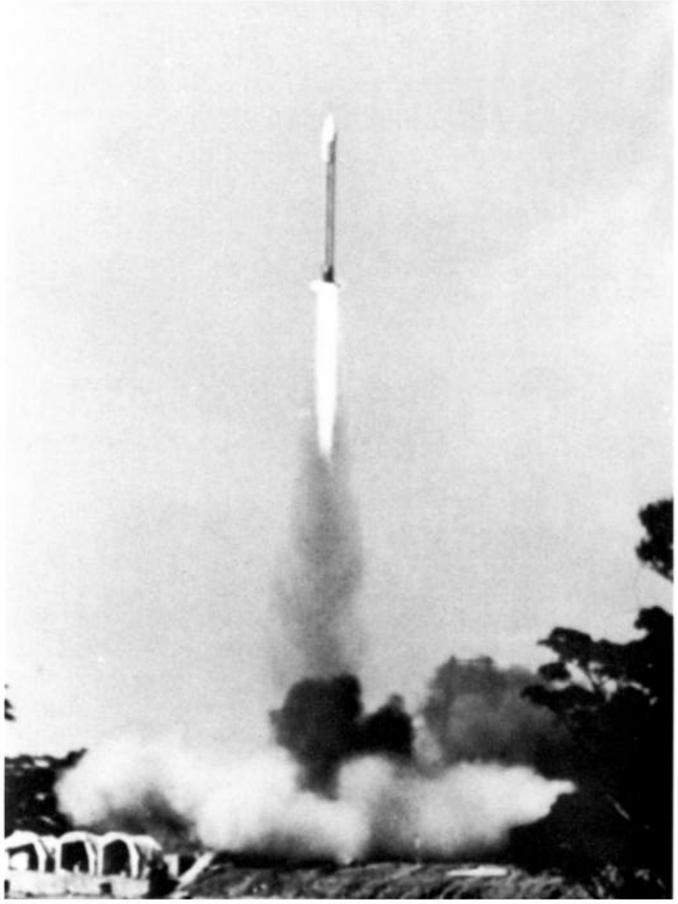
Dr. Lutz T. Kayser, President of OTRAG, showing a model of the "space truck."



Using partially filled fuel tanks, the rocket reached an altitude of somewhat over 10 kilometers.



The first OTRAG rocket: an assembly of 4 independent modules which burn diesel oil and nitric acid.



1st OTRAG rocket is launched successfully from Manono. North of Shaba.

. . . more on OTRAG

This test was important, because it verified the OTRAG concept of a powerful low-cost booster, which burns very cheap propellants in small and simplified engines, uses nitric acid for oxidizer and normal Diesel-oil as fuel. The most powerful model of OTRAG rockets would be a heavy launch vehicle, able to put 10 tons into a 300 km orbit or 1.5 tons into geostationary orbit (36,000 km high); this big rocket would be a compound with 600 basic units; its weight would exceed 1000 tons, its length would be approximately 40 m and its total thrust would be about 1600 tons at lift-off. The 600 modular units must be clustered in three packages, equivalent to the stages of the conventional launchers.

It was needed to find an appropriate launch site, near the Equatorial line, in order to have an easy access to the geostationary orbit. OTRAG and the Government of Zaire concluded together an agreement for the establishment of a large firing range on a territory of 38,000 miles^2 (100,000 km^2). OTRAG is building its space launch facilities on a plateau of 1300 m altitude. These facilities are located near the small city of Manono, North of Shaba. From there, site of the May 17 launch, the "space truck" will be fired in the early 1980's.

OTRAG's launch facility in Zaire, used for the May 17 launch.

Students Evaluate Space Industries

George Washington University management science professor Stuart Umpleby and Dr. James K. Wertz of Computer Sciences Corp. have joined forces this fall to teach "An Evaluation of Space Industrialization".

In a show of impartiality, the instructors have given students their choice of either G.K. O'Neill's *The High Frontier* or T.A. Heppenheimer's *Colonies in Space* as textbooks. Required texts are *Space Settlements, A Design Study* (NASA SP-413) and a compilation of special readings prepared for the course by the National Space Institute.

Solar Energy Calendar

18-19 OCT 1977: Atlanta, GA. Solar Total Energy Systems Workshop. Contact: Lyle Wetherholt. Sandia Laboratories, Albuquerque, NM 87115, 505-264-7017.

3-6 NOV 1977: Anaheim, CA. Energy Fair '77. Contact: Shirley Solomon, Energy Fair, Inc., 15915 Asilomar Blvd., Pacific Palisades, CA 90272, 213-459-1050 or 459-2777.

5-7 DEC 1977: Miami Beach, FL. Alternative Energy Sources: A National Symposium. Contact: Dr. Nejat Vaziroglu, Director, Clean Energy Research Institute, University of Miami, P.O. Box 248294, Coral Gables, FL. 33124.

Saito Calls for Japanese Space Colonies

An ad hoc committee of the Japanese Space Activities Commission (SAC) chaired by Dr. Shigefumi Saito filed a report with SAC July 28 exploring wide-range possibilities for Japanese space development activities during the last quarter of this century.

The 250-page report will be used by SAC in formulating a 15-year space development policy outline as well as intermediate working program covering period of three to five years. It is a product of a 2.5 year study performed by the ad hoc committee with cooperation of 30 top-level space scientists and engineers in Japan.

Titled "Long-range Vision on Japan's Space Development," the report calls among other things for Japanese participation in the U.S. Space Shuttle project while pursuing the already established independent development course. Participation in the Space Shuttle will not be limited to installing scientific equipment on board shuttle orbiter, but actual chartering of the shuttle and even having Japanese scientists on board is under consideration. Eventually, Japanese space activities would include a human space flight program with development of spacecraft and launch vehicles undertaken on its own, to meet requirements of the age of space stations.

Specifically the report proposes that Japan should charter the shuttle in 1982 to conduct useful scientific experiments and put Japanese scientists aboard the shuttle orbiter in 1983. Plans beyond that call for starting work for domestic development of a piloted spaceship and launch vehicle -- beginning with trial manufacturing of a 5-ton unpiloted spaceship and putting it on board the shuttle around 1985, to test ocean surface recovery. Subsequently, a 10 to 15 ton spaceship for a crew of up to three will be developed and launched into low orbit around 1990 using a cluster of liquid-hydrogen fueled rockets called H-l (with a diameter of three meters) and H-2 (with a diameter of five meters.)

Space developments contemplated for Japan to undertake in the next 25 years cover a wide range of activities. Japanese scientists and engineers are visualized as using satellites and spacecraft as observatories for scientific exploration of space, as lighthouses in space for ships and aircraft, as communication towers in space and as a base for supporting ground operations. Spacecraft will also be used as laboratories for physical and chemical research and experiment, as materials processing plants, as biological experiment stations, and as space colonies. The report also envisages Japanese exploration of the moon, planets and comets.

The Retainable Expendable

by Leonard David

The only throw-away part of the upcoming NASA Space Shuttle program for the 1980’s may have found a new lease on life and could lead to early development of an inhabited Space Station.

According to NASA engineers at NASA’s Marshall Space Flight Center in Alabama and Grumman Aerospace Corporation in New York, the only non-reusable part of the Shuttle’s propulsion system, the External Tank (ET), could be used as a core of a space platform for the mid-1980’s.

The external tank, measuring 48 meters (157 feet) x 8 meters (28 feet), carries over 703,000 kilograms (1,550,000 lbs) of liquid oxygen and liquid hydrogen powering the Shuttle Orbiter’s three Main Propulsion Engines. Working in tandem with the two solid strap-on engines, which are parachuted back to earth for reuse in a future Shuttle flight, the tank is unceremoniously “dumped” into a predetermined remote area of ocean after its work is done. The tank would be damaged beyond repair on impact.

However, NASA engineers see a brighter future for the tank. According to James Kingsbury, director of the Science and Engineering Directorate at the Marshall Space Flight Center, a major space platform could be placed in Earth orbit in less time than earlier believed, using the Space Shuttle’s External Tank. “From this permanent space platform,” Kingsbury believes, “the real business of space utilization can begin.”

The new NASA thinking would have a Shuttle keep its External Tank and carry it directly into orbit, “parking” it in a specified location in space. This tank, empty of its liquid propellants, would be “off’loaded” before launch of some 2,000 cubic feet of liquid oxygen, normally carried in the top portion of the tank. This empty space would hold equipment and supplies to handle a small crew for 90 days of habitation in orbit.

A second Shuttle launch would carry into orbit both an Airlock Module and a Multiple Docking Adapter, complete with solar electric conversion wing. All elements would be docked and clustered to the external tank, with the second Shuttle providing a crew to live in the platform. The assignment of this first crew would involve final construction of the crew’ quarters and establish structural integrity of the entire platform.

Expansion of this basic tank design could include additional external tanks, Spacelab modules, or even both, extending the station’s capabilities. The platform could be used in a number of ways, providing ample laboratory space to conduct space processing experiments, or manufacturing large space structures.

Although far from being an “on-going” concept, as a target, the current studies are directed to an initial launch in calendar years 1983-1984. Kingsbury feels that the current studies indicate a permanent space platform, using the external tank method, could be in earth-orbit at a fraction of the cost now estimated for a new developmental program, and at an earlier time frame than once thought.

Use of the ET method, even though NASA hates to admit it, may be the only alternative for an unwilling Administration that, as yet, has declined to provide NASA with substantial funding for large space stations. Even though the external tank concept could provide experience in building large habitats in space, NASA would much rather build all new hardware, specifically designed for space station construction.

OMB Weighs NASA Budget Cut

Budget Director Bert Lance, who recently resigned under fire, is reported to have told a group after touring Edwards Air Force Base in California, where the shuttle is being tested, that the National Aeronautics and Space Administration is being asked to “reassess its priorities.”

Lance did not present details, but said the space agency’s share of the federal budget-as well as expenditures by other agencies-would have to be measured in light of seeking a balanced budget and financing social programs.

It remained unclear what such a reassessment would mean to the projects for which the space shuttle craft is being designed. The craft, which is scheduled to be launched in March 1979, would be capable of carrying 65,000 pounds of material into space and make as many as 100 trips.

Carter’s budget for fiscal 1978 provides $4 billion for NASA, about the same amount the Ford administration gave the agency this year.

But Lance reminded reporters in California that the 1978 budget was largely put together before Carter took office and only the 1979 budget would accurately reflect the President’s budgetary views.

He emphasized that the administration remains committed to “zero-based” budgeting by which every agency of government is required to reassess its spending goals.

As a result, he said, there will be “a redirection of programs” in various agencies including those dealing with the space industry.

Frosch Wins Prize

NASA Administrator Dr. Robert A. Frosch has been awarded the L-5 Editor’s Proofreading Prize. The reward? A public apology from editor Carolyn Henson, who let one caption and two headlines slip by which referred to someone named “Frosh.” Additional proofreaders for the L-5 News are being sought avidly.

Schmidt Calls For “Starlaws”

Sen. Harrison Schmidt, (R-N.M.), ranking minority member of the Senate Commerce Committee Subcommittee on Science, Technology and Space and former Apollo astronaut, recently advised the American Bar Association that “An instantaneous and continuous view of earth and its total environment makes possible a wide spectrum of space activities. . . Starlawyers must quickly come to grips with the implications of this new view of Earth. . . There are numerous legal and regulatory questions that arise when one contemplates solar power systems in synchronous orbit around the earth. How do we establish national and/or international rates for power generated and transmitted to receiving points on earth? As more and more men and women work in space stations like this, what laws and judicial system will govern their interrelationships?

“Possibly the most urgent area of starlaw . . . is the extension of medical, corporate and patent law to cover the infinite range of treatment, research and industrial activities that will soon begin in space. Precedents are being set which may not be in the right direction either with respect to the interests of business, the interests of future consumers or the interests of our country.”

NASA: Priming the Pump

by Kenneth McCormick

In discussing the space industrialization concept with friends and acquaintances, I have discovered that what often underlies a seeming indifference to the subject in some people is a basic hostility toward NASA. Whatever merit space industrialization may have in its own right, it is inseparable, in the minds of virtually everyone I have talked to, from the history of the space program. The space program, judging from references in the mass media, is regarded by most to be a great thing, but neither justifiable as an extravagant expenditure of tax dollars, nor of any discernable benefit to the average citizen.

As a political statement, this attitude most often takes form as what has become one of the truly great cliches of our time: "Why are we spending all that money and effort in space, when there is so much to be done here on earth?" Proponents of this position usually offer as examples of what needs to be done here on earth: the elimination of poverty, improving public transportation, "cleaning up" the environment, and ending the spread of urban sprawl.

Thus stated, the attitude in question can be shown to rest upon two fallacies: (1) that NASA is a drain on public finances at a time when more money must be spent on social programs, and (2) that a political problem will yield to a technological solution.

I would like to recommend four studies which seem to me to be must reading for anyone promoting space ventures.

1. *The Political Economy of the Space Program*, by Dr. Mary A. Holman. Palo Alto: Pacific Books, 1974.
2. *"Economic Impact of Stimulated Technological Activity"*, Midwest Research Institute, Kansas City, Mo., November, 1971.
3. *"Quantifying the Benefits to the National Economy From Secondary Applications* of *NASA Technology"*, Mathematica, Inc., Princeton, N. J.
4. *"The Economic Impact* of *NASA R & D Spending"*, Chase Econometric Associates, Inc., Bala Cynwyd, Pa. April, 1976.

Few public libraries have any of these studies, but they can be gotten via interlibrary loan. The book costs about $30 new. The papers may be purchased from the National Technical Information Service, Springfield, VA. 22161. A reference librarian can be of assistance in placing an order with NTIS.

The U.S. owes its high standard of living to high worker productivity. Technological advances increase productivity. As less labor is needed per unit of output, unit labor costs are lowered which leads to lower prices. As prices are lowered (or at least grow at a less rapid rate), disposable income of consumers becomes greater. As consumers gain greater purchasing power, they demand more goods and services, which are now available due to increased productivity.

The Chase Econometric study demonstrated that NASA spending, in its long term effects, is quite uncharacteristic of government spending in general. NASA mission oriented R & D has been shown to be as effective in producing economic stimulation as any more highly diffuse R & D effort. The measured relationship between NASA R & D spending and technological progress was introduced into a number of simulations to measure the overall impact on the economy. It was found that if NASA R&D spending (R & D accounts for about three-quarters of the total budget) were increased by $1 billion in 1975, and if the increase were sustained at that level, the GNP would be $43 billion greater by 1988 than it would have been without a NASA increase. For a $14 billion investment over that period of time, there would be a return to the economy during the same period of $225 billion. Also, by 1984 the Consumer Price Index would be reduced to the extent of 2% lower than would otherwise be expected, the total number of jobs available would be 800,000 greater than would otherwise be expected, the Index of Labor Productivity would be 2% higher, and the rate of inflation would be 5.3%, rather than the expected 5.8%. Simulations using figures of $100 million to $500 million showed proportional results.

A decrease in NASA spending of $1 billion would have reverse effects of the same magnitude.

Since the federal budget is about 20% of the GNP, we can see that if NASA were to consume an extra $19 billion of public finances ($14 billion for R & D, $5 billion for construction and administration) over a 14 year period, federal finances would increase by about $28 billion (20% of $225

Impatient White House rejects proposed solar-energy satellites

By Jack Anderson

WASHINGTON-Americans are in a tizzy over the box office smash movie, "Star Wars." What they don't realize is that our own space agency is ahead of "Star Wars" in some of its concepts.

U.S. space scientists have come up with a futuristic scheme, for example, to supply the United States with all the energy it needs from outer space. It's a type of solar energy with a "Star Wars" twist.

The National Aeronautics and Space Administration would like to launch 20 giant satellites that would transform sunlight into electricity. The scientists claim that 20 satellites, microwaving the energy to earth, would be enough to supply the entire nation.

The solar-electric satellites would resemble enormous Venetian blinds. Each would measure several miles long. The frames would have a thin cover, dotted with millions of tiny solar power cells.

The project would take years of research and cost millions of dollars. Space officials, therefore, have turned to Congress for help. They contacted House Democratic leader James Wright of Texas, who recently arranged for the space experts to brief White House energy czar James Schlesinger and Budget Director Bert Lance.

To Wright's dismay, the White House rejected the space project-at least for now. White House officials called solar-electric satellites a long-term solution. They want immediate results.

The space experts, nevertheless, are certain the solar satellites will work. So the day may come when our energy will come from outer space instead of underground.

billion from R & D and $10 billion from the demand effects of other expenditures, minus the $19 billion investment) as the tax base expanded. So much for the assertion that NASA is a drain on public finances. So much, also, for the assertion that NASA produces little in the way of tangible benefits for the average citizen. I have found few things more persuasive to the political opinion of the man in the street than money in the bank.

The influence of stimulated technological activity should be considered in assessing the possible cost benefit ratio of space industrialization. The economic benefits which would be reasonably expected to come out of the R & D investment in the development of space would probably go a long way toward paying for the entire project. I am referring here, to government-funded space development, and not to development by private sector investment.

I would also like to recommend to L-5 Society members two booklets which describe some qualitative effects of NASA R & D.

1. "Why Space is Important to Our Future", available free of charge from the office of Public Relations, Rockwell International, Space Division, 12214 Lakewood Boulevard. Downey, CA. 90214.
2. "Spinoff 1977", free from the Office of Public Relations, NASA Headquarters, 306 Maryland Ave., Washington, D.C. 20546. (This 116 page booklet also has some dazzling color illustrations of Pioneer spacecraft, the Large Space Telescope, Shuttle, etc.)

One example of a NASA spinoff is a computerized X-ray scanning device which replaces exploratory surgery. There is no anesthesia, no pain, and no hospitalization, since the operation can now be performed on an out-patient basis.

Another example is the Meal System for the Elderly, which will result in better nutrition for the handicapped or infirm. These are the sort of technological advancements that it is difficult to place a monetary value on.

Congress displayed a lack of wisdom in allotting $16 billion for the creation of new jobs during 1977, while eyeing the already slim NASA budget for the possibility of further cuts. The $4 billion NASA budget provides more jobs, in the long run, than the $16 billion voted for make-work. Cutting back on NASA funds in order to get more money to eliminate poverty makes no sense, of course, since the Chase study shows that this action would, over time, create more new poverty than the money taken from NASA could eliminate. Any attempt to end poverty which would attack the means of production will benefit no one. The question of whether or not to explore and exploit space is quite apart from the question of whether or not poverty should be permitted to continue in this country.

No amount of technological brainstorming by NASA rocket scientists will solve any problem of a social nature. It has been suggested that NASA talent could improve public transit systems. This has, in fact, happened, but the automobile remains the preferred means of transportation because the government spends many times as much to improve highways as to improve mass transit. Hence, this is a social problem.

Anyone appreciative of the subconscious determinants of political behavior will probably agree that much of the cause of hostility engendered by NASA is symbolic in nature. NASA's crew-cut, middle-class astronauts, with their technical jargon, conspicuous consumption, A-OK's and golf on the moon, were always the ideal representations of the establishment organization man. At a time when it was becoming ever more clear to all that the establishment had denied full participation in society to great numbers of people, a prominent display of macho potency on the part of the establishment, as seen in the first great rocket flights, was out of place. (The skeptic may note that many people joked after the U.S.' first satellite's launch failure that the U.S. had failed to "get it up.")

To the degree that a person is alienated from the mainstream of society, that person will tend to view the success of space ventures as a cause for jubilation in the camp of his or her enemies. If we are to get general agreement on the desirability of the further use of space, then people will have to come to realize that it is, and always has been, something that benefits everyone.

Go up, young MAN, Go up!

So You Want to Lobby?

by Marc Boone

If you write to legislators . . . Ask them to vote a specific way, support a specific amendment, or take a specific action. Otherwise you will get a "motherhood" response. They will say in a general way, "Of course I am in favor of the space shuttle, solar power satellites" or whatever you asked. Then they might vote the wrong way.

The basic means by which a Congressperson keeps in contact with his or her district is through letters. Never underestimate their importance. Telephone calls to the local office or even to Washington are often useful, but letters provide the basic demonstration of interest and expression of opinion concerning an issue.

The volume of mail a Congressperson or Senator receives varies with many factors. Legislators from primarily rural areas usually receive less mail, but a speech or newspaper article may stimulate a large volume on a certain day. No matter how many letters are received, each one is opened, read, and catalogued. Thus, there is a tally in every Congressperson's office of voter interest and sentiment on different issues. The legislator is told daily, or at least weekly, how voter interest is running. He or she is told again before a vote.

Every Congressperson knows that voters are often too apathetic to express their preferences in writing. When a person does take the trouble to write, legislators assume that the writer's position must also be held by a large number of other people in the district. In other words, they feel that every letter represents the sentiments of 50, 100, or even 500 voters in that district. A letter-writing campaign, therefore, is an important lobbying tool. There are certain techniques of letter-writing that you should use and recommend to co-workers.

1. *Always be courteous.* Never reprimand legislators for taking the wrong position. Instead, try to convince them to take the right one-politely.

2. *Try to keep the letter to one typewritten page.* Complex letters are often put aside to be answered later and may lose their effectiveness. If you have more material than will fit onto one page, include extra background pages, but label them clearly as background and put your name and address on them in a comer. These pages will probably be routed to the staff person handling the issue and so will have more impact.

3. *Do not write about more than one issue in each letter.* That only confuses the staff and dilutes your impact.

4. *Don't use a form letter.* It only takes minutes to write a few sentences of your own, and such a letter is much more effective. Try to add a few sentences about the issue's impact on the legislator's district.

5. *If you write to a Congressperson who is not your own,* try to think of a relative or friend in his or her district that you can mention; i.e., "although I am not now living in your district, my family has told me about your dedication to planetary exploration, space industrialization, etc. Also, . . ." Send a copy to your own legislator and clearly indicate that you have done so on the bottom of your page. Otherwise, your letter may be routed to your own Congressperson as a courtesy, and the legislator you want to influence will be bypassed.

6. *If you are writing to criticize or praise a bill,* be specific as possible. If you do not know the bill number, try to describe the bill by its precise name, such as the "NASA FY '78 Appropriations Bill."

7. *If you are writing about an amendment,* try to include the bill number, who will offer the amendment, and what the amendment will do.

8. *If possible, refer to the Congressperson's past actions on your issue* or some other related issue. Including this kind of reference shows that you are aware of his or her past record and that you are following the issue closely. If you write to the legislator and ask to be included on the newsletter list, you will become more aware of his or her attitudes.

9. *Be specific.* Ask him or her to vote a specific way, support a specific amendment, or take a specific action. Otherwise you will get a "motherhood" response. The legislator will say in a general way, "Of course I am in favor of the space shuttle, solar power satellites" or whatever you asked. Then he or she might vote the wrong way. In order to be effective, you must be specific so you can hold legislators accountable for their actions.

Be courteous . . . . Be specific. . . . Don't be a crackpot . . . . .
WRITE!

"Congress in session is Congress on exhibition, Congress in committee is Congress at work."
-- Woodrow Wilson

10. *It is always wise to try to meet the Congressperson* (if you can do so without alienating him or her.) Then you can refer to your meeting in the first few sentences of your letter. Call the district office to ask for a schedule of office hours and public meetings.

11. *Do not come on like a crackpot.* If you support the space program because you want to see star ships or meet extraterrestrials, then write short polite letters asking your Congressperson for support for reasons that they would agree with.

By phone -- To reach Washington offices of Members of Congress or Congressional Committees, dial 202/224-3121 and "the Capitol" will answer and give you the proper extension upon request.

By letter-For Senators or Senate Committees, write to:

The Honorable ____________________
(or Senate Committee on ____________)
United States Senate
Washington, D.C. 20510

For Representatives or House Committees, write to:

The Honorable ____________________
(or House Committee on ____________)
House of Representatives
Washington, D.C. 20515

Although writing to any legislator is helpful, writing to one who sits on one of the committees which handles the NASA budget is ten times as good. The NASA budget request for the coming year goes through four different committees and is voted on four different times on the floors before it is presented to the President. The committees and subcommittes which must be persuaded are presented below in the order that a bill reaches them.

What Happens to the NASA Appropriations Bill?

First the bill goes to the HOUSE SCIENCE AND TECHNOLOGY COMMITTEE, 2321 RHOB, 202/225-6371.

Democrats:
Olin Teague, Tex., Chairman

Don Fuqua, Fla.
Walter Flowers, Ala.
Robert Roe, N.J.
Mike McCormack, Wash.
George Brown, Jr., Calif.
Dale Milford, Tex.
Ray Thornton, Ark.
James Scheuer, N.Y.
Dick Ottinger, N.Y.
Tom Harkin, Iowa
Jim Lloyd, Calif.
Jerome Ambro, N.Y.
Robert Kreuger, Tex.
Marilyn Lloyd, Tenn.
James Blanchard, Mich.
Timothy Wirth, Colo.
Stephen L. Neal, N.C.
Thomas J. Downey, N.Y.
Doug Walgren, Pa.
Ronnie G. Flippo, Ala.
Dan Glickman, Kans.
Bob Gammage, Tex.
Anthony C. Beilenson, Calif.
Albert Gore, Jr., TEnn.
Wes Watkins, Okla.
Richard A. Tonry, La.
Republicans:
John Wydler, N.Y.
Larry Winn, Jr., Kan.
Louis Frey, Jr., Ga.
Barry M. Goldwater, Jr., Calif.
Gary Myers, Pa.
Hamilton Fish, Jr., N.Y.
Manuel Lujan, Jr., N.M.
Carl D. Pursell, Mich.
Harold C. Hollenbeck, N.J.
Eldon Rudd, Ariz.
Robert K. Dornan, Calif.
Robert S. Walker, Pa.
(Minority Vacancy)

and then is voted on by the House. Then it goes to the SENATE COMMERCE, SCIENCE AND TRANSPORTATION COMMITTEE, 5202 DSOB, 202/224-5115

Democrats:
Warren G. Magnuson, Wash., Chairman
Howard W. Cannon, Nev.
Russell B. Long, La,
Ernest F. Hollings, S.C.
Daniel K. Inouye, Hawaii
Adlai E. Stevenson, Ill.
Wendell H. Ford, Ky.
John Durkin, N.H.
Edward Zorinsky, Nebr.
Donald Riegle, Mich.
John Melcher, Mont.
Republicans:
Robert P. Griffin, Mich.
Ted Stevens, Alaska
Barry Goldwater, Ariz.
Bob Packwood, Ore.
Harrison Schmitt, N.M.
John C. Danforth, MO.

and the SENATE COMMERCE SUBCOMMITTEE ON SCIENCE AND SPACE, 2301 RSOB, 202/224-6477

Democrats:
Adlai Stevenson, Chairman
Wendell Ford
Russell Long
Ernest Hollings
Edward Zorinsky
Donald Riegle
Republican:
Harrison Schmitt
Barry Goldwater
Robert Griffin

and then is voted on by the Senate. Then it goes to the HOUSE APPROPRIATIONS COMMITTEE, H-218 (Capitol), 202/225-2771

Democrats:
George H. Mahon, Tex., Chairman
Jamie L. Whitten, Miss.
Robert L.F. Sikes, Fla.
Edward P. Boland, Mass.
William H. Natcher, Ky.
Daniel J. Flood, Pa.
Tom Steed, Okla.
George E. Shipley, Ill.
John M. Slack, W. Va.
John J. Flynt, Jr., Ga.
Neal Smith, Iowa
Robert N. Giamo, Conn.
Joseph P. Addabbo, N.Y.
John J. McFall, Calif.
Edward J. Patten, N.J.
Clarence D. Long, Md.
Sidney R. Yates, Ill.
Frank E. Evans, Colo.
David R. Obey, Wis.
Edward R. Roybal, Calif.
Louis Stokes, Ohio
Gunn McKay, Utah
Tom Bevill, Ala.
bill Chappell, Jr., Fla.
Bill D. Burlison, MO.
Bill Alexander, Ark.
Edward I. Koch, N.Y.
Yvonne Brathwaite Burke, Calif.
John P. Murtha, Mich.
Robert Duncan, Ore.
Joseph D. Early, Mass.
Max Baucus, Mont.
Charles Wilson, Tex.
Lindy Boggs, La.
Adam Benjamin, Jr., Ind.
Norman D. Dicks, Wash.
Republicans:
Elford A. Cederberg, Mich.
Robert H. Michel, Ill.
Silvio O. Conte, Mass.
Joseph M. McDade, Pa.
Mark Andrews, N.D.
Jack Edwards, Ala.
Robert C. McEwen, N.Y.
John T. Myers, Indiana
J. Kenneth Robinson, Va.
Clarence E. Miller, Ohio
Lawrence Coughlin, Pa.
C.W. Bill Young, Fla.
Jack F. Kemp, N.Y.
William L. Armstrong, Colo.
Ralph S. Regula, Ohio
Clair W. Burgener, Calif.
George M. O'Brien, Ill.
Virginia Smith, Neb.

and the HOUSE APPROPRIATIONS SUBCOMMITTEE ON HUD-INDEPENDENT AGENCIES, H-143 (Capitol), 202/225-3241

Democrats:
Howard P. Boland, Chairman
Bob Traxler
Max Baucus
Louis Stokes
Tom Bevill
Lindy Boggs
Bill D. Burlison
Bill Alexander
Republicans:
Lawrence Coughlin
Joseph M. McDade
C.W. Bill Young

and then is voted on in the House. Then it goes to the SENATE APPROPRIATIONS COMMITTEE, 1235 DSOB, 224-3471

Democrats:
John L. McClellan, Ark., Chairman
Warren G. Magnuson, Wash.
John C. Stennis, Miss.
Robert C. Byrd, W. Va.
William Proxmire, Wis.
Daniel K. Inouye, Hawaii
Ernest F. Hollings, S.C.
Birch Bayh, Ind.
Thomas F. Eagleton, MO.
Lawton Chiles, Fla.
J. Bennett Johnston, La.
Walter D. Huddleston, Ky.
Quentin Burdick, N.D.
Patrick Leahy, Vt.
James Sasser, Tenn.
Dennis DeConcini, Ariz.
Republicans:
Milton Young, N.D.
Clifford Case, N. J.
Edward W. Brooke, Mass.
Mark O. Hatfield, Ore.
Ted Stevens, Alaska
Charles McC. Mathias, Jr., Md.
Richard S. Schweiker, Pa.
Henry Bellmon, Okla.
Lowell P. Weicker, Conn.

and the SENATE APPROPRIATIONS SUBCOMMITTEE ON HUD-INDEPENDENT AGENCIES, S-128 (Capitol), 202/224-7274

Democrats:
William Proxmire, Chairman
John C. Stennis
Birch Bayh
Walter Huddleston
Patrick Leahy
James Sasser
Republicans:
Charles McC. Mathias, Jr.
Clifford P. Case
Edward W. Brooke
Henry Bellmon

and then is voted on by the House and passed to the President.

If you want to learn more, the lobbyist's bible is the Congressional Directory, available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
$6.50

JOP Scoreboard

by Carolyn Henson

July 19, 1977 was an historicdate: for the first time, a House committee's recommendation to delete NASA funds was rejected by Congress. The rescued project? Jupiter Orbiter Probe, the first planetary exploration mission which will be launched by the space shuttle.

The House rejected the fund cut by a lopsided margin, 281 to 131.

Who were JOP's opponents? A quick check of the Congressional record reveals that the following Representatives voted for the deletion of JOP:

Alexander
Allen
Andrews. N. Dak.
Aspin
AuCoin
Baldus
Baucus
Bauman
Beard. R.I.
Bedell
Beilenson
Benjamin
Bennett
Biouin
Boland
Bonior
Bonker
Bowen
Brodhead
Brown. Mich.
Broyhill
Butler
Carr
Cochran
Conte
Coughlin
Daniel, R.W.
Danielson
Delaney
Dellums
Dingell
Duncan, Oreg.
Edgar
Edwards, Ala.
Eilberg
Evans, Colo.
Evans, Ind.
Findley
Fish
Fisher
Fiorio
Fraser
Frenzel
Gephardt
Goodling
Gudger
Harrington
Heckler
Hefner
Holtzman
Hughes
Jacobs
Jenkins
Jones, N.C
Keys
Kostmayer
Krebs
LaFalce
Latta
LeFante
Lederer
McDade
McKay
Mahon
Markey
Marlenee
Mazzoli
Mikva
Miller, Calif.
Miller, Ohio
Minish
Mitchell, Md.
Moakley
Murphy, Pa.
Murtha
Myers, Michael
Natcher
Neal
Nix
Oberstar
Obey
0ttinger
Panetta
Patten
Pike
Pressler
Preyer
Pritchard
Quie
Quillen
Rahall
Rangel
Regula
Reuss
Richmond
Rodino
Roncallo
Rooney
Rose
Rosenthal
Ruppe
Russo
Ryan
Schroeder
Shipley
Simon
Skubitz
Slack
Smith, Iowa
Slarz
St. Germain
Staggers
Stark
Stoker
Studds
Taylor
Thompson
Traxler
Treen
Tsongas
Vanik
Volkmer
Weaver
Weiss
Whalen
Whitehurst
Whitley
Whitten
Wylie
Yates
Zablocki

Those who voted "nay" (i.e., who opposed the JOP fund deletion) were:

Abdnor
Addabbo
Akaka
Ambro
Ammerman
Anderson, Calif.
Anderson, Ill.
Andrews, N.C.
Annunzio
Applegate
Archer
Burton, John
Burton, Phillip
Byron
Caputo
Carney
Carter
Cavanaugh
Cederberg
Chappell
Chisholm
Clausen, Don H.
Dornan
Downey
Drinan
Duncan, Tenn.
Eckhardt
Edwards, Calif.
Edwards. Okla.
Emery
English
Erlenborn
Evans, Del.
Evans, Ga.

PROBING JUPITER'S ATMOSPHERE -- *Red-hot nose cone separates from probe portion of Jupiter Orbiter Probe as it "hangs on the shrouds" and samples the atmosphere of the largest planet in the solar system. Painting depicts key moment in flight of JOP, the new planetary project planned by Caltech's Jet Propulsion Laboratory. The JOP spacecraft will be launched in January 1982 -- the first planetary mission aboard the space shuttle -- and will arrive at Jupiter late in 1984. The probe will enter the sunlit side of Jupiter's atmosphere and provide the first direct sampling of that planet's atmosphere. Jet Propulsion Laboratory has over-all management responsibility for JOP. NASA's Ames Research Center is responsible for development of the probe.*

Armstrong
Ashbrook
Ashley
Badham
Bafalis
Barnard
Beard, Tenn
Bevill
Biaggi
Bingham
Blanchard
Boggs
Breaux
Breckinridge
Brinkley
Brooks
Broomfield
Brown, Calif.
Brown, Ohio
Buchanan
Burgener
Burke, Calif.
Burke, Fla.
Burleson, Tex.
Burlison, Mo.
Guyer
Hagedorn
Hall
Hamilton
Hammerschmidt
Hanley
Hannaford
Hansen
Harkin
Harris
Harsha
Hawkins
Heftel
Hightower
Hillis
Hollenbeck
Holt
Hubbard
Huckaby
Hyde
Ichord
Ireland
Clawson, Del.
Cleveland
Cohen
Coleman
Collins, Ill.
Collins, Tex
Conable
Conyers
Corcoran
Corman
Cornell
Cornwell
Cotter
Crane
Cunningham
D'Amours
Daniel, Dan
Davis
de la Garza
Derrick
Derwinski
Devine
Dicks
Diggs
Dodd
McFall
McHugh
Madigan
Maguire
Mann
Marks
Martin
Mathis
Mattox
Meeds
Metcalfe
Meyner
Mikulski
Michel
Milford
Mineta
Mitchell, N.Y.
Moffett
Mollohan
Montgomery
Moore
Moorhead, Calif.
Fary
Fascell
Fithian
Flood
Flowers
Flynt
Foley
Ford, Tenn.
Forsythe
Fountain
Fowler
Frey
Fuqua
Gammage
Gaydos
Giamo
Gibbons
Gilmam
Ginn
Glickman
Goldwater
Gonzalez
Gore
Gradison
Grassley
Runnels
Santini
Sarasin
Satterfield
Sawyer
Scheuer
Schulze
Sebelius
Sharp
Shuster
Sikes
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Skelton
Smith, Nebr.
Snyder
Spellman
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Stangland
Stanton
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Steiger
Jeffords
Jenrette
Johnson, Calif.
Johnson, Colo.
Jones, Okla.
Jones, Tenn.
Jordan
Kasten
Kastenmeier
Kazen
Kelly
Kemp
Ketchum
Kildee
Kindness
Krueger
Lagomarsino
Leach
Leggett
Lehman
Lent
Levitas
Lloyd, Tenn.
Long, La.
Long, La.
Long, Md.
Lott
Lujan
Luken
Lundine
McClory
McClosky
McCormack
McDonald
McEwen
Moorhead, Pa.
Moss
Mottl
Murphy, Ill.
Murphy, N.Y.
Myers, Gary
Meyers, John
Nedzi
Nichols
Nowak
O'Brien
Oakar
Patterson
Pattison
Pease
Pepper
Perkins
Pettis
Pickle
Poage
Price
Purcell
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Roberts
Robinson
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Rogers
Rostenkowski
Rousselot
Roybal
Rudd
Stockman
Stratton
Stump
Symms
Thone
Thornton
Tucker
Udall
Ullman
Van Deerlin
Vander Jagt
Vento
Waggonner
Walgren
Walker
Walsh
Wampler
Watkins
Wayman
White
Wiggins
Wilson, Bob
Wilson, Tex.
Winn
Winn
Wirth
Wolff
Wright
Wydler
Yatron
Young, Alaska
Young, Fla.
Young, Mo.
Young, Tex.
Zeferetti

Those remaining on the sidelines were:

Badillo
Bolling
Brademas
Burke, Mass.
Clay
Dent
Dickinson
Early
Ertel
Fenwick
Flippo
Ford, Mich.
Holland
Horton
Howard
Koch
McKinney
Marriott
Nolan
Seiberling
Teague
Trible

L-5 And The Jewish Community
or
Yiddishkeit in Orbit

by Bruce Friedman

Well, folks, the Allen J. Reiter Lodge of B'nai B'rith in Annapolis, Maryland is getting involved with the drive for space colonization. How did this come about? Where will this lead?

The story starts early this year when I decided that I wanted to become more active in my relations with the Jewish community in my new hometown of Annapolis. I joined B'nai B'rith. About a month later, I attended a meeting at the local Synagogue at which a speaker from B'nai B'rith Headquarters gave a talk. It turned out that headquarters did not have much going in the way of energy policy. Not only that, it turned out after I had a conversation with this speaker later that he was not aware of potential new sources of energy, such as solar power satellites (SPS's). This situation struck me as not being very satisfactory, particularly from the point of view of the situation in the Middle East.

Next day, I was talking with my friend Dr. Ernest H. Halpern (henceforth to be referred to as Ernie) about the meeting, at which he had also been present. He suggested that I organize an energy committee for our lodge and that I be chairman of this committee. I though about this for a few hours before I decided to do it. Picking up the phone, I called Mr. James W. Jacobs (Jim), the president of our lodge. He heard me out and as he is empowered to do, declared the energy committee to be in existence with myself as chairman. Fast work!

Since that time the energy committee has been gradually getting involved with people and issues of the multi-faceted exceedingly complex energy situation. Considering, however, that I am a long time space enthusiast and that I joined the L-5 Society in early 1976, explains why educating people about solar power satellites, space factories, and non-terrestrial resources is a significant part of our program.

The energy committee is small but has a lot of expertise in science and technology. Aside from myself, it includes Ernie (whom I consider to be my "chief of staff"), Jim, and Dr. Herman B. Urbach. Ernie was originally somewhat skeptical about solar power satellites, space factories, and space colonies. Now, he has acquired some of my enthusiasm for all of these things. In fact, at one of our local B'nai B'rith board meetings he started referring to the energy committee as being the space committee!!

From the special point of view of the American Jew, what is the appeal of space colonization and SPS's? Well, one thought is that American-built and operated SPS's mean a U.S.A. independent of energy from Arab oil. In this event, America could formulate solutions to the troubles between Israel and the Arab world without the threat of an oil embargo.

Further thought upon the matter yields the possibility of something more positive. How about a joint Israeli-Arab SPS-space colony project? After all, the Arabs have all of that oil wealth and Israel has loads of scientific and technical talent. This could really advance the cause of peace in the Middle East. Anyhow, the Arabs should be worrying about what is going to happen to themselves when their oil runs out. An SPS-space colony project makes quite a bit of sense for the Middle East. Just picture it! The first space colony being peopled by Moslems and Jews (maybe with some token WASP's).

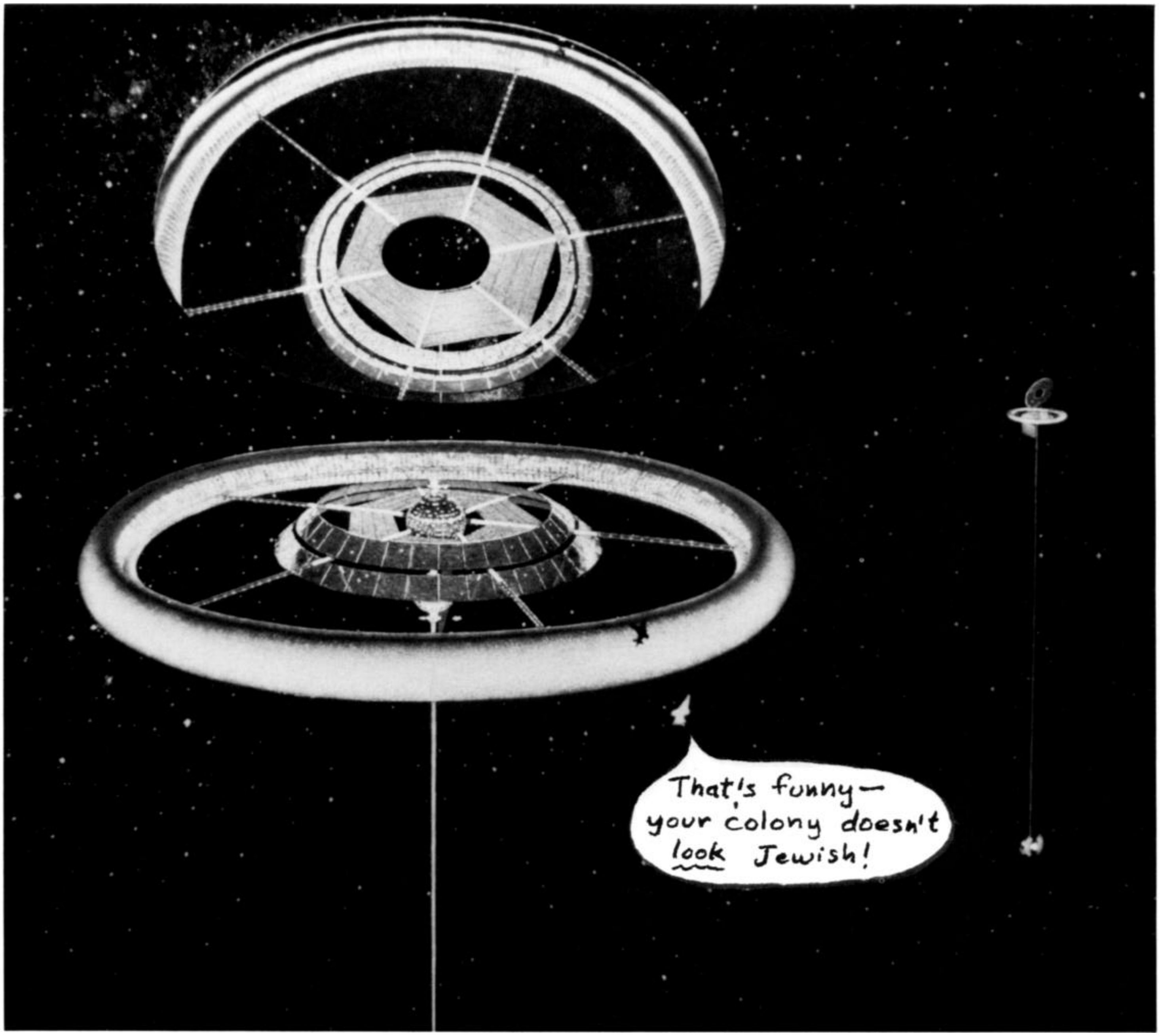
From a more somber attitude, considering the vicissitudes of the Jewish people throughout history, one could say that Jews, of all people, should be interested in space colonization. Space colonization could be considered a form of life insurance if things should get tougher again for the Jews on earth. More optimistically, colonization could be viewed as a wonderful opportunity for the expression of Jewish vitality in far-flung and diversified environments. (Actually, all of the ethnic groups could have their own colonies.)

How does the energy committee go about gaining acceptance for its space proposals? One thing we do not do is talk about space colonization per se. We think in terms of pushing for the construction of SPS's by a space factory using non-terrestrial resources. This, hopefully, avoids the "pie-in-the-sky" reaction from uninformed people upon first hearing about space colonization. We feel that the notion of people working and living in space would be thought of more naturally as a corollary to the SPS-space factory plan. It makes sense to have people living near their work instead of commuting between earth and space constantly. One would think of a company town as being an apt comparison.

What modes of communication does the energy committee utilize? We find a cookout to be an effective format. A few people, knowledgeable in an aspect of the energy problem, are invited to join us in Annapolis. We eat, drink and have fun while trading information and formulating plans for action. We hope to meet with state and national legislators, other B'nai B'rith lodges, and other influential people. We have already met with the Aberdeen, Maryland lodge of B'nai B'rith. As a result of this cookout the energy committee will be presenting a series of resolutions concerning the energy problem to the Maryland State Association of B'nai B'rith with the backing of the Aberdeen lodge. Particular mention of SPS's will be made.

Our activities are coordinated with other advocates of space colonization/industrialization. Since my joining the L-5 Society in 1976 I have been in touch with Dr. T. Stephen Cheston of Georgetown University who is well known to all L-5ers. Since the formation of the energy committee, Steve and I have been trying to coordinate our activities.

At the time at which I am writing this article, the energy committee is working on involving the members of the B'nai B'rith Youth Organization (BBYO) in its space activities. We are preparing a number of projects for BBYO in the areas of solar power satellites, space industrialization, and space colonization. The energy committee believes that BBYO


That's funny— your colony doesn't look Jewish!

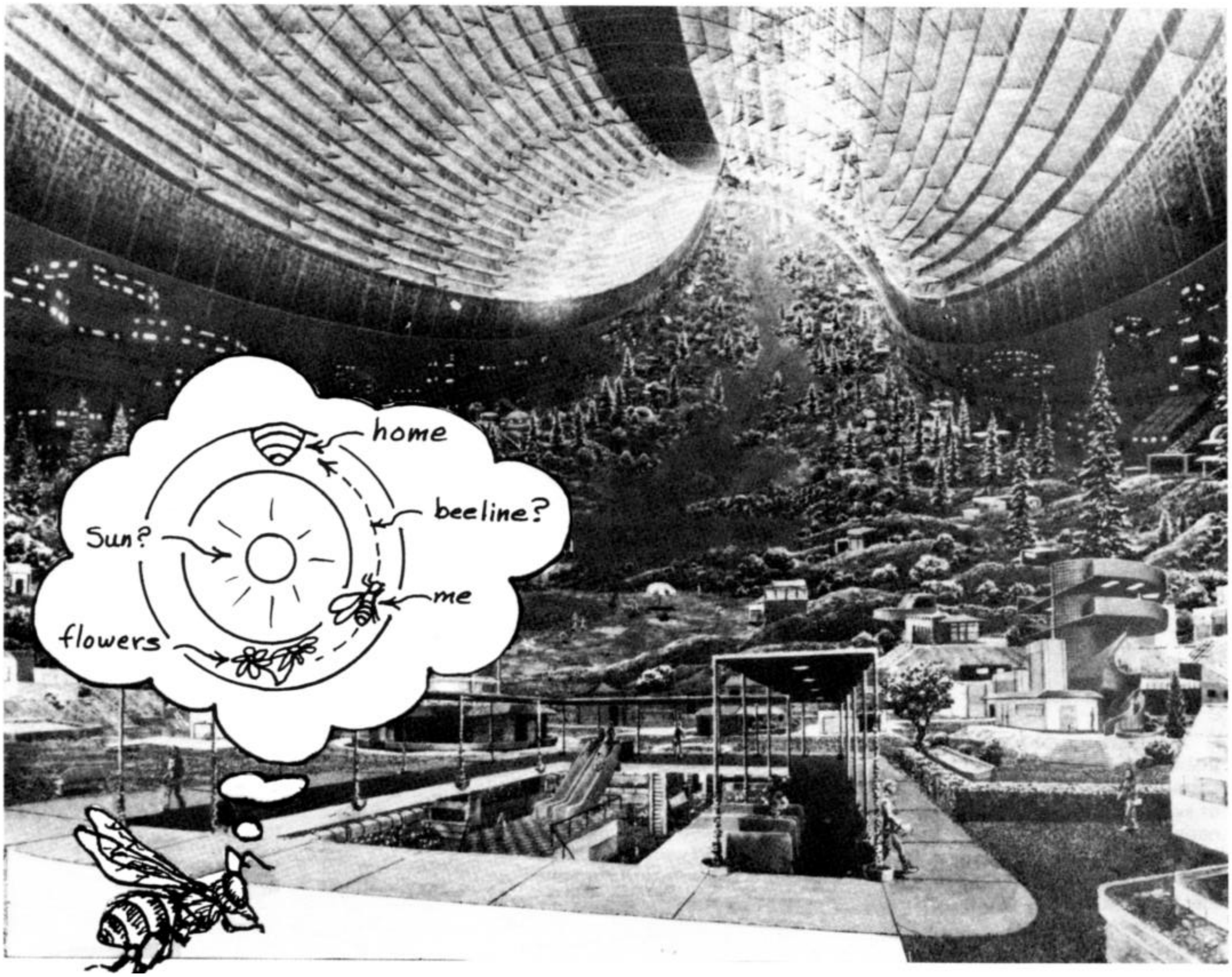
members could be of value in educating the public as to the benefits to be derived from these space programs. More directly, BBYO members could organize study groups in order to investigate various problems and perform experiments to help fill in thedetails needed to be known before implementation of these programs. This direct action on a volunteer basis could be of great importance in filling the gap between now and when the major funding becomes available. The BBYO is potentially a valuable resource of enthusiastic, intelligent young folks.

We believe that our experiences here in Annapolis can be of use to others in striving for the implementation of SPS's and space colonization/industrialization. For example, other ethnic service organizations could do the same things we are in B'nai B'rith. Why not have a Knights of Columbus lodge form an energy, or even a space committee? Then, possibly, our energy committee could link up with theirs and all of us could get into space sooner. Of course, we do not have to confine ourselves to religious-based organizations. Certainly the Lions and the Elks could help out also.

Another point that we believe to be important is convincing the minorities of our nation of the relevance of space to the fulfillment of their needs. We do not want these people to think of us as elitists but as people who are really concerned about them. This fits in with the Jewish ethic. One cannot be considered a good Jew unless one is a good person. The aid of the minorities could certainly help us in our goal of spreading out into the universe.

We have a very positive outlook over in B'nai B'rith. We want to accomplish our goals for our generation and not have to wait for the next generation. Our thoughts and actions are strictly in terms of success now, in the coming years, in the next decade or so, certainly no later than the end of this century. Moses saw the promised land from afar but he was not allowed to enter it. We, on the other hand, will enter our promised land.

About the author: Bruce Friedman holds a Ph.D. in physics. He works at the David W. Taylor Naval Ship Research and Development Center in Annapolis, Md. His major area of research is pollution abatement. He encourages those of you who want to learn more about how to develop local L-5 oriented projects to write him at 1284 Graff Court Apt. lB, Annapolis, MD 21403, or call him at 301/267-9271 (home) or 301/267-3543 (office).



A Land of Milk and Honey?

Not if the bees can't find their way home, according to Magoroh Maruyama.

With respect to pollinating bees' orientation, Gerard O'Neill has assured me that the direction of polarization of sunlight inside the space community will remain ground-stationary because the mirrors will be ground-stationary, and the direction of polarization is largely determined by the angle of the mirrors.

A problem may arise when several mirrors are used to cover several areas, and the bees have to traverse these several areas between the hive and the flowers. As you know, the bees' brain stores information regarding the location of the flowers in terms of (1) direction; and (2) distance. The direction is identified in reference to the polarization of the sunlight.

It is not known what happens to the bees' information system when they have to traverse several areas, in which the direction of light polarization is different from one another.

But this can be experimented on the Earth. In a large hangar, you can install a bee-hive. The hangar should be opaque to prevent natural daylight from coming in. Artificially polarized daylight by means of mirrors, in such a way that different sections of the hangar have different directions of polarization, can be installed. Then live flowers are put in, in such a way that the bees have to traverse many sections of the hangar to reach the flowers. We can then observe: (1) the shape of the "bee dance" in the hive to communicate the location of the flowers; (2) actual flight path of the bees who received the information from the dancer.

Another complication is bee's reaction to gravitationally non-Euclidean space (Torus, in which the equipotential surface is non-flat and eventually goes upside down; or cylinder and torus, in which the "bee-line" changes the tangential angle to the equipotential surfaces during one flight). This can be experimented in a large centrifugal chamber.

"Space Settlements: a Design Study" (NASA SP-413), recently was published by NASA's scientific and technical office. It describes in vivid terms and illustrations the construction and operation of permanent settlements in space where as many as 10,000 people at some future time may work, raise families and live out their lives. The 185-page volume is based on a study sponsored by the American Society of Engineering Education and NASA, held at the Ames center and Stanford University, in which 31 engineers, scientists and students participated. The book is priced at $5.00, on sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20301 (stock number 033-000-00669-l).

Space Shuttle: Who Can Go?

by Carolyn Henson

Space, once the preserve of highly trained supermen (and one superwoman) is about to open up to ordinary people, according to Dee O'Hara, administrator of a NASA program at Ames Research Center (Moffet Field, Calif.) which is studying human response to simulated shuttle flights.

Last spring, a group of 10 women aged 35 to 45 volunteered to take a simulated shuttle flight. They were spun at 3 g's in a centrifuge to simulate takeoff and then were required to remain absolutely flat on their backs for a month so as to simulate the weightlessness of zero g. Even raising their heads higher than one pillow was verboten. They exercised, flew flight simulators and took tests in this horizontal position. The women were responsible for maintaining their complex medical monitoring equipment (biobelts) as well.

To simulate the isolation of space the subjects, while allowed phone calls, were not allowed visitors. (There was also concern that visitors might bring in the latest viruses.) Test participants had round the clock medical supervision. However, the test facility doesn't have a "hospital" atmosphere; NASA workers and test participants wear street clothes.

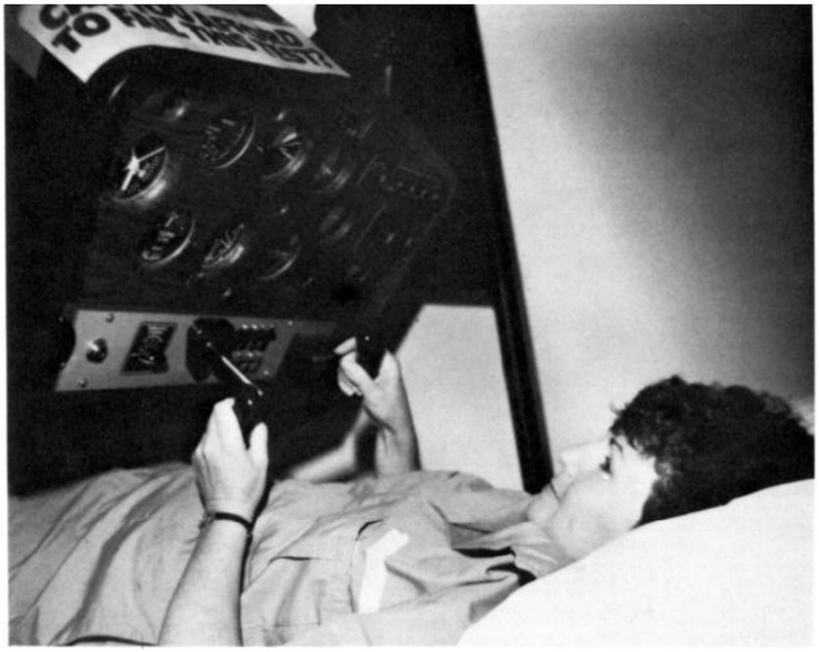
How did those women fare? They all passed the physical, mental and psychological tests.

Having determined that the average male or female up to age 45 can handle a shuttle mission with flying colors, NASA is now planning tests on women and men aged 45 to 55, followed by tests on people of both sexes up to age 65. If you would like to help NASA in this project, and get a paid one month vacation to boot, call: Lynne Dunham, Management System Associates, 415/964-0702.

Cardiovascular System Tests -- Nichelle Nichols, with Astronaut Alan Bean, demonstrates how the lower body negative pressure device operates in medical projects designed to help solve problems encountered in space. Volunteers at the Ames Research Center are participating in this and other medical research involving human participation in space shuttle voyages.

Gloria Martinez of Milpitas, CA, is being strapped into a NASA human centrifuge during tests at Ames Research Center, Mountain View, CA, to see how women in the 35-45 age group react to 3 g's in simulated space flight. Assisting is Jerry Rose (left) and Don Gundo.

Charlene "Kitty" Johnson pedals a horizontal bicycle in an exercise test at NASA's Ames Research Center. Because of the requirement for test subjects to remain horizontal in order to simulate the effect of weightlessness on the cardiovascular system, exercise testing must also be done with the subject prone.


TO FAIL THIS TEST?

Nance Lou Deardorff, of San Jose, California, "flies" a small flight simulator at NASA's Ames Research Center. Ms. Deardorff is one of ten women in the 35-45 age group who participated in a month-long test program to see how they react to simulated space flight. A newspaper clipping taped to the top of the simulator reads "Can You Afford to Fail This Test?" The simulator, which is "flown" twice a day, is used to measure performance during the study. Bedrest simulates the weightlessness of space flight.

Volunteers for Stress Studies -- The ten women selected as participants in the 27-day medical test at the Ames Research Center were: (top row, l. to r.) Rita L. McIntire, electronics technician; Marion Hays, freelance writer-actress; Wendy L. Heyman, drapery manufacturer; Chrisula Asimos, teacher-medical researcher; Christine Smith, homemaker-registered nurse; (bottom row, l. to r.) Charlene D. Johnson, retail sales clerk; Mary C. Gerbino, housewife-freelance writer; Carol Pruit, vocational nurse; Gloria A. Martinez, technician; and Nancy Lou Deardorff, banker.

SPORTS IN SPACE

Excerpted from “The High Frontier”
by Gerard K. O’Neill

For good health we should spend some of our time in Earth-normal gravity; yet much of the ‘recreation in which the residents of space indulge will surely take advantage of a new option we can never experience on Earth: to have any gravity they like, simply by riding or walking to the right distance from the cylinder axis. On the axis itself gravity will be zero, and it will increase smoothly toward Earth-normal as the valley floor is approached.

Surely new sports will be invented to make use of this degree of freedom: three-dimensional soccer may be one example. Some old sports will also be a great deal more enjoyable in low-gravity. In a pool near the cylinder axis, a dive will be made in slow motion and the waves will break as slowly as in a dream. Those of us who enjoy diving find that under Earth’s oceans the need for pressure equalization reminds us, with every foot of depth change, that we’re not in our natural element. A pool near the cylinder axis, or an entire sea-world, perhaps on one of the external cylinders, could have a gravity as small as a thousandth that of Earth, and could give the swimmers of the habitat the freedom to forget pressure changes and swim as naturally and freely as the fish.

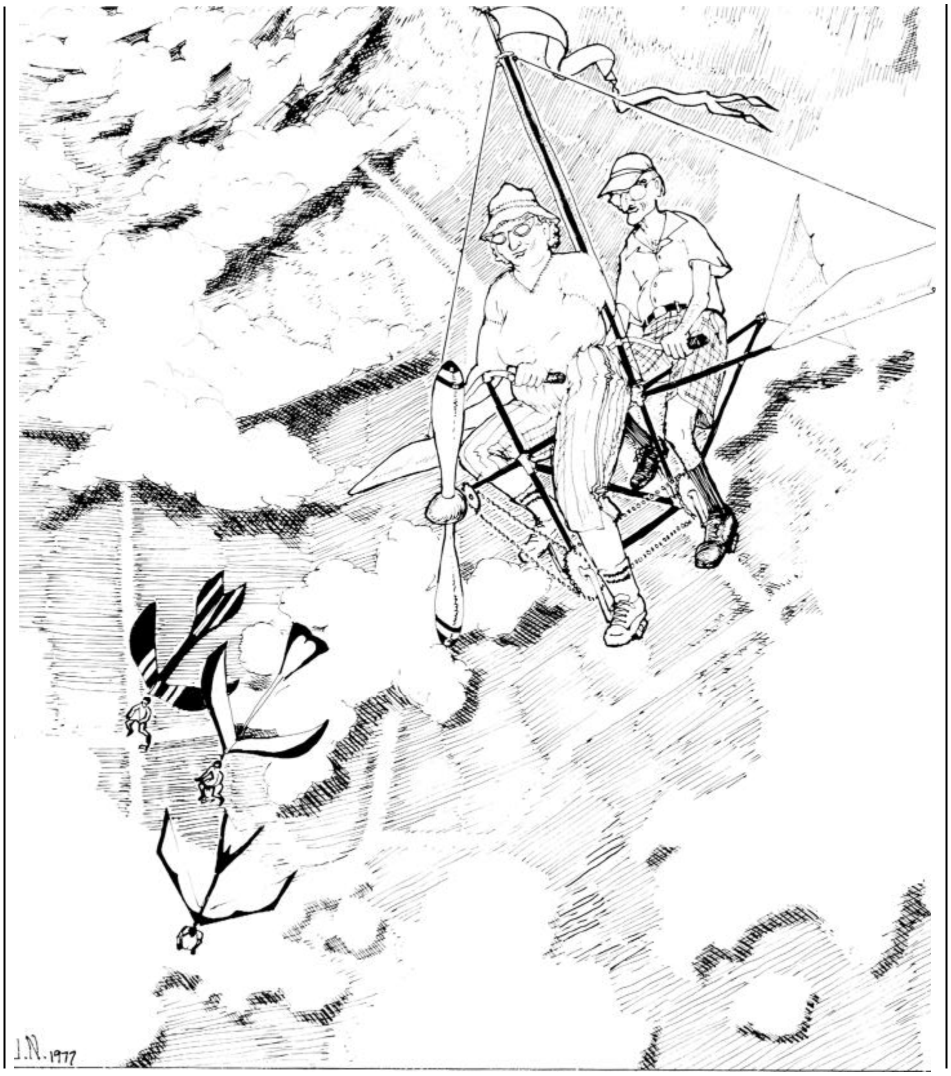
It seems unlikely that any of the communities will be willing to put up with powered aircraft, because of their noise and smoke, but soaring-the use of air currents to sail in three dimensions with a glider-should be possible. As a glider pilot, I find that people even on the ground seem to feel a sensation of joy and release in watching a glider fly; as Richard Bach has said, perhaps there is something of Jonathan Seagull in each of us.

From the time of classical Greece, and perhaps even before, some men have been fascinated by the idea of flight by human power alone. Leonardo da Vinci was obsessed by it, and filled notebooks with sketches of machines that he hoped might fly. In modern times, human-powered aircraft have been flown short distances, but under Earth-normal gravity human-powered flight remains an almost impossible dream. In space communities, it will become easy for everyone, not just for athletes. Near the cylinder axis, where gravity will not be more than a tenth or a twentieth that of Earth, almost every imaginable variety of human-powered flying machine, including some of Leonardo’s, will work. We can imagine elderly ladies and gentlemen taking their evening constitutionals by gently pedaling their aircraft, while viewing the world two miles below them. Because they will be in a “gravity” which is produced by rotation, they will be able to change it at will, by flying with or against the direction in which the habitat turns. At a distance of a hundred yards from the axis, they will experience three percent of Earth-normal gravity. If they choose to fly against the direction of rotation, at a speed of only eleven miles per hour they will cancel gravity entirely.

As at swimming beaches, space dwellers may have to provide something to keep people out of danger-in this case a near-invisible cylindrical net to prevent a tired flyer from straying too far from the cylinder axis into a high-gravity region.

Where the valleys end and the hemispherical endcap begins its upward curve toward the cylinder axis, the temptation will be great to model the mountains of Old Earth. A hike up those mountains will be a good deal easier than on Earth: as the climber makes his way to higher altitude, and starts to become tired, gravity will be lessening with every foot of height gained. At the 7,000 foot elevation above the valley floor, he will weight only 30 percent as much as he did on Earth or at the start of his walk, and can climb in bounding strides. At the top, 10,000 feet above the valley, he will weigh nothing at all. He will have passed the clouds at about the 3,000-foot level, so they will be far below him, but he will find that the atmosphere has lowered in density only as much as for a 5,000 foot climb on Earth.

Much of this chapter has been devoted to the less serious side of space colonization; not questions of economics and production, but of amusement and diversion. It seems appropriate to close with an account of one memorable lunchtime conversation: in the years before the topic of this book was well known, I had made a practice of challenging skeptics to name their favorite sports, and then always pointing out that the sport could be done better in space than on Earth. Finally someone named a delightful sport that, even in these uninhibited days, is carried on only in private. The skeptic instantly became a believer: can one imagine a better location for a honeymoon hotel than the zero-gravity region of a space community?



Science Faction Bookshelf

by Robert Anton Wilson

Exo-Psychology
by Timothy Leary
Peace Press, Los Angeles, 134 pp., $8

Prolongevity
by Albert Rosenfeld
Knopf, New York, 1976, 250 pp., $8.95

The Immortalist
by Alan Harrington
Celestial Arts, Millbrae, 1977, 313 pp., $5.95

It is getting harder and harder to draw a line between science-fact and science fiction, because the implications of current science are often more staggering than anything published in *Analog* or *Galaxy* ten years ago, or five years go, or even two years ago. The rate of acceleration of social-technological change is itself changing at an accelerating rate; Prof. Gerard O'Neill's latest space-city designs are already more futuristic than the Clarke-Kubrick space-ships in *2001.*

Dr. Timothy Leary has accepted the interpenetration of science-fact and science-fiction cheerfully, as an inevitable development; he calls his new book, *Exo-Psychology,* "science-faction," on the grounds that his facts come from science while his style is deliberately science-fiction in flavor.

Exo-Psychology is an astonishing performance even for the Most Controversial Man in America. It's only 134 pages long, but it incorporates hundreds of new ideas in psychology, neurology, ethology, genetics, sociology and dozens of other sciences, making it one of the most compressed, condensed, highly charged books I've ever seen. Attempting to summarize it is like attempting to summarize the *Britannica;* to review it is like reviewing 20th Century culture itself.

Leary asserts that DNA was seeded on Earth (and on millions of other planets) by Higher Intelligence. This does not mean "the police-court Jehovah" of monotheism, he says. Higher Intelligence *might* be (a) an advanced interstellar civilization, as suggested by Nobel geneticist Sir Francis Crick, the first to propose that DNA was seeded here; or (b) ourselves-in-the-future traveling backwards in time, as suggested by physicists Jack Sarfatti and Saul Paul Sirag; or (c) sub-atomic consciousness, as suggested by physicist Evan Harris Walker.

Higher Intelligence, Leary proceeds, designed the DNA to evolve, through metamorphoses and migration, into ever more complex and more intelligent forms. Evolution is not guided by "least possible effort and greatest possible blunder" (Neitzsche's caricature of Darwinsism) but by a pre-programmed "brain" within the DNA tape-loop.

All living organisms, then, are survival-machines designed by DNA to transport itself about, reproduce itself and create more and better DNA. In short, we are, as geneticist Herbert Muller likes to say, "giant robots" programmed by DNA for its own purposes; we are "fragile, easily replicable units," Leary adds, because DNA can make myriads of duplicates of us.

At each stage of development, each individual robot takes a new imprint in the ethologocial sense and thus mutates from one "tunnel-reality" to another. For instance, the emotional game-playing of the toddling infant recapitulates mammalian territorial rituals, and the infant lives in a primate tunnel-reality at the stage. The school-child learning to parrot lessons lives in a Paleolithic tunnel-reality. The adolescent gang recapitulates the barbarian horde (Attila, Genghiz Khan, etc.) The domesticated adult lives in the tunnel-reality of his or her tribal guilt-virtue game.

No conditioning techniques, Leary insists, can permanently change such imprints. Skinner's Behavior Mod works only so long as the conditioner has the victim more or less imprisoned and totally controls reward and punishment. Once the subject gets free of the conditioner, behavior drifts back to the biochemical circuits of the original imprint.

On the other hand, Leary says, if you can learn to serially re-imprint your own nervous system, you graduate to a new level of evolution, which he calls I^2, which means intelligence-squared, or intelligence-studying-intelligence, i.e. the nervous system studying and re-imprinting itself. You can then become as smart as you wish, as brave as you wish, as happy as you wish, as wise as you wish. This is a quantum jump above the robot-level at which animal life, and most of humanity have functioned hitherto.

There is no end to this serial re-imprinting. "The more intelligent you become," Leary says, "the more you see the advantage in becoming even more intelligent."

The result of this self-metaprogramming is that all the Utopias and Heavenly visions of our imagination can be achieved; we need only imprint these possibilities to make them neurologically real, and then we can begin making them physically real. "Since no one can allow the game to become bigger than Hir concept of the game (what is not imprinted is not real to the primate brain) therefore let us define the game as large, fast, intense, precise as possible: Unlimited Space, Unlimited Time and Unlimited Intelligence to enjoy same."

Leary summarizes this goal into the acronym SMI^{2}LE, which means Space Migration, Intelligence^2 and Life Extension. After the neuro-psychology of imprinting is clarified, most of *Exo-Psychology* deals with the practicality of beginning this Triple Mutation immediately.

Albert Rosenfeld's *Prolongevity* deals with 1/3 of Dr. Leary's Triple Mutation program -- Life Extension. Rosenfeld, who was science editor of *Life* for 11 years and is now science editor of *Saturday Review,* seems to have interviewed *everybody* engaged in Life Extension research in the United States-or, if not, he probably didn't miss more than a few of them. They all agree that a quantum jump in human lifespan is a very real possibility very soon.

There are degrees of optimism, of course; some speak of merely doubling human lifespan, adding another 70 years; others talk of extending life into centuries or thousands of years; one chapter is devoted to scientific Immortalists, who think we can conquer death entirely sooner or later.

Prolongevity (a title James Joyce would have loved) is sheer science-faction; the implications are staggering, but the sources are all reputible scientists, who have hard facts to back up their hopes.

Rosenfeld concludes with a 40-page philosophical discussion titled "Should We Do It?," in which he discussed the arguments against Life Extension and finds them all weak and short-sighted.

Longevity, to Rosenfeld, means "To have time to travel everywhere and go back again and again to favorite places. To go on learning-new skills, new sports, new languages, new musical instruments . . . To read everything you want to. read. To listen to all the music. To look at all the pictures, and even paint a few. To savor and re-savor experience and arrive, not at boredom but at new levels of appreciation . . ."

"There could arise a new breed of human being," Rosenfeld says, "who, merely by virtue of longevity, through

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About the author: **Robert Anton Wilson** is a former senior editor of **Playboy.** He has since turned to freelance writing; his recent science fiction trilogy, **Illuminatus** (coauthored by **Robert Shea,** editor of the **Playboy Forum)** has been adapted to the stage and is playing to packed houses in Western Europe.

acquisition of a steadily maturing wisdom and a steadily expanding awareness, could finally become . . . a being worthy to be the trustee of our future evolution."

Rosenfeld agrees with Leary that DNA has programmed us (all life-forms on this planet) to survive, reproduce and die. He also suggests that, in creating humanity, DNA programmed a robot conscious enough to resent death and intelligent enough to do something about it eventually.

Leary and Rosenfeld could say, like Gurdjieff, "Our way is against God and against Nature"-except that they see DNA (the modern equivalent of what mystics meant by "God" and "Nature") as programming this rebellion also. As a "self-developing organism" (Gurdjieff's term), Humankind seems to have been programmed with all the characteristics necessary to transcend the limitations of biological life as it has hitherto existed on this planet.

The ultimate, or a kind of ultimate, in this line of speculation is Alan Harrington's *The Immortalist*, which may be as important as *Das Kapital* or *The Origin* of Species or *The Golden Bough.* Harrington, an old friend of Kerouac and Ginsberg and one of the original creators of the Beat Generation of the 1950's, has not mellowed out on Buddhism, tranquilized himself with Transcendental Masturbation, or collapsed into paranoia and bitterness. Instead, he has become more revolutionary and more Utopian over the years. *The Immortalist* is one of those rare books that challenges you to re-think your basic philosophy about the universe *totally.* It is the literary equivalent of finding a rattlesnake in your bedsheets; you can't ignore; you have to take a stand and make a decision about it.

When Harrington last spoke in Berkeley, a few months ago, he was shouted down and booed off stage in a demonstration of hooliganism that hasn't been seen here since Alan Watts was similarly mistreated by Left Fascists back in 1966. It is, of course, a tribute to both Watts and Harringon that they were not permitted to speak; this shows how powerful their ideas are, and how frightening such ideas are to certain neophobes.

The Immortalist carries current life extension research and theory to the logical conclusion: Humanity, Harrington proposes, can and should ultimately conquer death.

"Death," Harrington says, "is an imposition on the human race, and no longer acceptable."

"Let us hire the scientists," he says, "and spend the money, and hunt down death like an outlaw."

Where Rosenfeld provides the scientific evidence that longevity and eventual immortality are possible, Harrington tackles the much heavier question of their desirability, and does not hesitate to damn and blast every organized ideology based on the acceptance of death. Those who love death, Harrington insists, have the right to die; but they have no right to tell those who love life that we have no moral or metaphysical right to extend it indefinitely. He is quite willing to dance on their graves, but he is not going to let them persuade him to crawl into the grave next to them.

The Immortalist smashes more sacred cows, questions more "unquestionable" dogmas, assaults more prejudices than any single book I have ever read. Gore Vidal has already said, with some awe, "Mr. Harrington may have written the most important book of our time." I would go further: Alan Harrington has written the most important book of the millenium.

"Poor Allen Ginsberg," Tim Leary said to me recently. "He lives in constant fear that the future is going to be different from the past." The same fate has overtaken most of the radicals of the '50s and '60s, who are now the most nostalgic and reactionary people around. Alan Harrington stands head and shoulders above all of them, looking bravely into the future while they day-dream wistfully of a dead and irrelevant past.

Entertainment

Space Opera Debut

L-5: A Space Opera will open at Keystone Korner in San Francisco October 31. The producer is Ron Giteck. Music director is Eddie Snakepit Edwards; models are being built by Blaine Lemert, and holograms of the models will be projected onstage by Multiplex, Corp. Technical advice is being provided by the L-5 Society.

Producer Giteck, a systems engineer/anthropologist turned Bay Area music critic and opera librettist, promises an "upbeat" view of the future that nevertheless "grapples with our fears."

Space Habitat Display

by Jay Vivian

The California Academy of the Sciences in Golden Gate Park, San Francisco, is currently showing a space settlement display of interest to L-5ers. It's bordered with excellent photographs, including one of a weightless Skylab astronaut blowing a water globule, and a view of San Francisco Bay from 200 miles up. It was apparently done by NASA; it is quite well-done, very accurate, and reasonably realistic.

The display consists of a series of consecutive windows which are arranged sequentially in an arc. They begin with a good moving-lights representation of the lunar mass-driver hurling pieces of Moon into space, including (get this, you detail freaks!) the buckets actually slowing down at the end of their track for their return and accelerating during their hurl cycle. Other windows include one on power satellites, and a rotating Bernal Sphere, which is the best demonstration I've seen of watching the neighbors down the street "walk on the ceiling." If you put aside your embarassment and crouch down to an 8-year-old's height (if you can push all the 8-year-olds out of the way!), you're actually *there.*

The display is a bit low-level; regular readers of the News won't get much out of it. But go anyway; the Academy is fun, and it's worth it to see all the excitement the display generates. When I was there I heard one very little girl ask "can we go there on our next vacation?" Maybe not her next one, but . . .

L-5 Radio News

L-5 members can now tune in to "The Joyful Wisdom Program," a music, news and information show scanning the planet Earth for signs of intelligent life. This futuristic radio show is nationally syndicated, usually as FM Sunday programming.

The show features music and commentary on futuristic topics with the likes of Jerry Brown, Timothy Leary, Barry Goldwater, Stuart Brand, Gerry O'Neill, Carl Sagan, and John Lilly; not to mention Grace Slick, Linsay Wagner, Paul McCartney, Lonnie Liston Smith and Fleetwood Mac.

Of special interest to L-5ers is the "L-5 File" featuring, among others, Carolyn and Keith Henson, and "Evolution News." The show also carries special features called "Conversations With Higher Intelligence" and an evolutionary soap opera, "As the Earth Learns."

Check your local listings!

Synergy Coalition

The L-5 synergy coalition is changing its name to the 'Earthrise Synergy Coalition.' The coalition also has a new address:

Earthrise Synergy Coalition
c/o S.A. Varugnese
R.D. 2 Box 707
Sussex, N.J. 07461

Projects underway:

Project moonbase: object, to design a small, low cost personed research base on the surface of the moon.

Needed personnel: closed system ecologist/agronomist, nutritionist, social scientists, vacuum engineer, etc.

Project leader: Larry J. Freisen

Political Activities Committee: the need for positive action on behalf of the space colonies in the political arena is evident. The Political Action Committee will act as a lobby, generally making the government recognize solar energy from space and space habitation as a serious and timely matter.

Needed personnel: people to act as liaison between persons with various interests such as national energy independence, equalization of world resources, clean energy alternatives, space resources utilization, etc., also needed are persons to write letters and to monitor congresspersons.

Project coordinator: Jim Bennet

If you are interested in any of these projects, or would like to get involved in an up-coming project, write to the coalition.

Is There a Mayflower in Your Future?

by Carolyn Henson

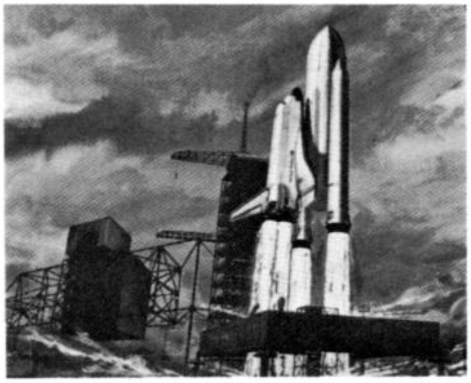
Many cultures have a history of epic migrations. The United States is one. For hundreds of years, wave after wave of people, eventually millions strong, boarded ships all over the world and sailed to their new land.

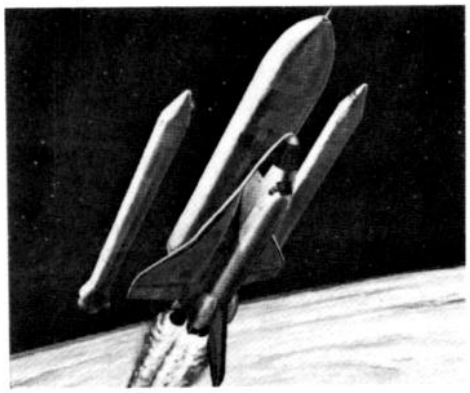
Some were prisoners or slaves; their fates wrote new chapters in humankind's grim history of brutally exiled and uprooted people. But others, like the Pilgrims, worked and prayed for the opportunity to make new worlds for themselves. The first ship they sailed, the Mayflower, was small, creaked in a distressing manner during storms, and was as crowded as the worst slave ship. But her people boarded freely. No government bureaucrat told them who had to go or who couldn't. They followed their dream.

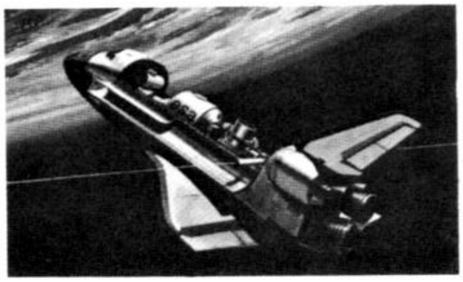
The shuttleorbiter 101, now being tested in a series of free flights, was named Enterprise after a space ship in a popular television series, Star Trek. The U.S. government had originally planned to name it "Constitution" but adopted its present name after a nationwide letter writing and petition gathering campaign persuaded President Ford to back the Enterprise name change.

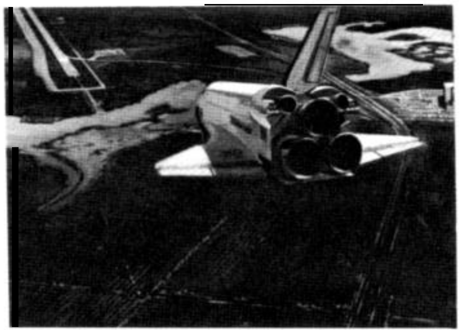
However, Enterprise will not be the first shuttle orbiter in space. Her yet unnamed sister ship, orbiter 102, is being outfitted for a space flight in 1979 which will be the first in what will soon become routine shuttle missions.

George Koopman (see Sept. L-5 News pg. 2) has suggested that we name orbiter 102 the "Mayflower". And as we watch the first shuttle breakthrough into space, perhaps we can dare to hope that within this century, free people all over the world will once again begin to board ships for new worlds.









Letters

As an eleventh-grader, it appears to me that, while your generation will be the one to appropriate the initial funds for the research into the developments of S.S.P.S.'s, space colonies, etc., our generation will be the one that actually votes "yes" or "no" for development of the first colony, that makes up the board of directors that says "yea" or "nay" to a proposed space factory, and so on. So, since our generation will be the one to -- or not to -- develop space exploitation, I think a major effort should be placed on "gettin' 'um while they's young". Now, for two questions in that respect:

1) What can supporters of space exploitation of all ages do to encourage young people to want to see space exploited?

2) What can us young people do to help encourage other young people to want space exploitation, and to help get the wheels turning?

Don Campbell
San Juan Capistrano, Calif.

You can help by getting your friends to join the L-5 Society and/or the National Space Institute. Write in to the L-5 office at 1620 N. Park, Tucson, AZ 85719 for free L-5 buttons, brochures, leaflets, etc. The National Space Institute is more strongly geared toward high school students than we are, although they put less emphasis on actually getting jobs and homes in space some day. They can be reached at 1911 N. Ft. Meyer Dr. Suite 408, Arlington, VA 22209.

And what makes you think us ancient folks over 30 will be too creaky to go in another 15 or 20 years -- you young whipper-snapper! -- CH

I believe that L-5 members who are also educators, will wish to know about *NASA Report to Educators*, a quarterly publication available to educators without cost by writing to the Educational Program Division, Office of Public Affairs, Code FE, National Aeronautics and Space Administration, Washington, D.C. 20546. The report often lists various materials available from the government on space related topics. These include a number of excellent 16 mm films on Skylab, remote sensing of the Earth and exploration of the Moon and Mars, which can be borrowed by educators without cost.

Jay S. Huebner
Jacksonville, FL

I am unable to comprehend the logic behind the statement which was made by Budget Director Bert Lance. He has stated that work on the 1979 fiscal year federal budget has begun and a sharp cut in NASA's space programs is possible.

NASA is now working with a bare minimum budget which is less than one percent of the national budget. I cannot see how NASA could survive as a space agency if there is a sharp reduction in the size of the budget NASA now has.

I believe a dramatic example of how budget cuts affect NASA is the Jupiter orbiter/probe mission in 1978's fiscal year budget. At question was seventeen to eighteen million dollars, hardly a sharp cut in funding. However, without those funds America would no longer have a planetary flight capability.

As a private citizen the only thing I can do is ask my fellow American citizens to write President Carter asking him to support a strong and effective space program in the federal budget for fiscal year 1979.

G.M. Wannamaker
FPO New York

I am a student at John Muir High School, Pasadena, and one of motion picture production. I am currently working on a super-8 sound film project about space colonization. This effort won't be quite on the same level of "Star Wars," but could well pave the way for future releases of that sort. With my interest in filmmaking as it is, I realize the potential film has for bringing across concepts and ideas.

With a broad range of technical expertise help, it will be possible to produce a film communicating to the audience the possibilities of space colonization, the problems, and benefits. The film will revolve around a tightly scripted plot and story. Realizing that this type of project will have competitors already, I am refraining from detailed discussion of contemplated scenarios, specific technological concepts, etc. I am working in conjunction with several L-5 society members who have worked in the space industry for many years, and I am striving to form a team to back this effort on a conceptual, operational, and financial basis. Those who would like to learn more about the film, and partake in our effort will be invited to attend a briefing in Pasadena this fall, upon inquiry to the following address. We're not asking L-5 members to do everything for us on a voluntary basis, but we do need the opinions, advice and talent from those members and associates who also feel a film is in order now, to educate people and get them excited about space colonization.

We solicit the interest of those who cannot attend the briefing also, and welcome their correspondence. The members of our team have a strong desire to promote the idea of space colonization-more rapidly, more graphically, more vicariously, so that more people can see the potential of space colonization, and back it more forcefully. We want to see this thing become a reality in our own lifetimes. Your support will be greatly appreciated, as in any effort in its beginning stages, we need it badly. Thank you for any help you may be able to give. In accordance with our new slogan, "Space is the place for the whole human race," we can most assuredly state, a star is born. . . . space colonization! Address inquiries to:

SPACEHAVEN
attn. Daren Nigsarian
1250 Wabash St.
Pasadena, California 91103

Much of the sunlight which could be caught by geosynchronous power stations and microwaved to terrestrial destinations for conversion to electricity would otherwise have shot right on by the Earth. A consequence, which I have not yet seen soberly commented upon, is increased insolation and, hence, a higher mean temperature. Under the climatic circumstances that man has enjoyed for 20,000 years, this extra heat would soon melt Antarctica's ice and flood all major seaports, rather forcing attention on the advantages of high-in-the-sky habitations. But, it appears, we are in luck. There is solid confirmation that we terrestrials are on the brink of a new Ice Age (if last winter did not convince you) born of certain resonance conditions in Earth's orbital mechanics. Unless the microwaves have untoward side effects, it look like we might make our migration to L-5 at a leisurely pace.

John R. Kirk
New Paltz, N.Y.

Well, you finally published a part of one of my letters, although my comment was placed in a negative light by the previous letter in the page. I am glad you didn't give my full address since I have no desire to receive 100 page refutations of my stand. Now, placing foot firmly in mouth, I will continue with commentary.

I feel that in the interest of international cooperation we should send copies of all test results and design specifications of the experimental mass driver to every country with money invested in space, Russia in particular, since we only want into space who cares which country provides the means? If Russia decided to develop the mass driver in conjunction the Salyut space station as a viable space exploitation (yeah, I said "exploitation") device, maybe our government would get in gear on our programs.

The success of an organization as a lobbying force depends on the assurance that the members can write to Congress without using form letters. Also, petitions are probably as effective as letters, especially when from registered voters in the politician's district. We could take some pointers from the NRA in their fight against the attack on our right to keep and bear arms. They attack the politicians on the basis of their stand on one issue regardless of any of the politician's other attributes. Are we willing to do the same to achieve our goals?

Now, back to the original problem of the equatorial countries. These countries wish to claim the geosynchronous orbit space above their countries. This is about as significant as claiming a 23,000 mile coastal zone. While we are getting this straightened out, let's settle the problem of giving every country access to sea resources. The U.N. is useless in solving this problem since its directives have all the force of a wet noodle. If China, for example, went into space industrialization I doubt that the wishes of Equador would carry much weight. One of the reasons for space industrialization would be to free us from the scarcity of earth resources: we won't be hamstrung by international cartels trying to gouge the best price for materials that they couldn't use or develop on their own. Space should not be subject to piracy. It's not our nationalism, but that of small countries that is causing the problems. I can just see the Idi Amin memorial SPS. Neutrality is useless unless backed by deterent. Maybe violence is the last refuge of the incompetent, but I am not too impresses by the competence so far exhibited by our leaders. I am afraid we will take our natures into space. In fact, space must be settled so that we will have a social group bound together by space instead of nationality. Conflict abounds and the easy or intellectual way may not prevail. Is there one economist or politician that has done as much to end large scale war as Einstein did with $E=MC^2$?

Richard Strong
Swartz Creek, MI

What's Available from the L-5 Society?

Books:

The Hunger of Eve, A Woman's Odyssey Toward the Future, Barbara Marx Hubbard Stackpole Books, Hardbound. 1976	B1	$ 8.00
The High Frontier: Human Colonies in Space, Gerard K. O'Neill William Morrow & Co., Hardbound. 1977	B2	$ 8.00
Colonies in Space, T. A. Heppenheimer Stackpole Books, Hardbound. 1977	B3	$12.00
The fourth Kingdom, William J. Sauber Aquari Corp., Hardbound. 1975	B4	$ 6.00
War and Space, Robert Salkeld Prentice-Hall, Inc., *Unbound copy,* 1970	B5	$ 7.00
Exopsychology, Timothy Leary Peace Press, Paperback. 1977	B6	$ 8.00
Colonies in Space, Frederic Golden Harcourt Brace Jovanovich, Hardbound. 1977	B7	$ 8.00

Posters:

Bernal Sphere Interior 14" x 22" full color	PO1	$ 2.00
Bernal Sphere Exterior 14" x 22" full color	PO2	$ 2.00
Pioneer XI in the Rings of Saturn Adolph Schaller 17" x 22" full color	PO3	$ 3.00

Postcards:

Bernal Sphere Interior	PC1	$ .15
package of 50	BPC1	$ 3.00
Bernal Sphere Exterior	PC2	$ .15
package of 50	BPC2	$ 3.00

Back Issues:

L-5 News, Volume 1:1-16, Volume 2:1-6	BI #	$ 1.00
Complete set of back issues	BIA	$22.00

Otherwise Unpublished Papers:

"Space Resources and the Human Race," W. L. Hurd. Jr.	22pp.	UP2	$ 1.54
"The Nature of Space Law," Scofield and Morgan	123pp.	UP4	$ 8.61
"Space Manufacturing from Nonterrestrial Materials, 1976 NASA Ames/OAST Study"	240pp.	UP5	$15.00

Reprints:

"Satellite Power Stations," William C. Brown, *IEEE Spectrum,* March, 1973.	P1	$ 1.00
"Colonies in Space," *Time,* June 3, 1974.	P2	$ .37
"Colonization of Space," Richard M. Reiss, *Mercury,* July/August, 1974.	P3	$ .86
"The Colonization of Space," Gerard K. O'Neill, *Physics Today,* September, 1974.	P4	$ .93
"Lagrangia: Pioneering is Space," Gerard K. O'Neill, *Science News,* September 21, 1974	P5	$ .37
"An Orbiting Solar Power Station," *Sky and Telescope,* April, 1975	P6	$ .51
"Colonizing the Heavens," Isaac Asimov, *Saturday Review,* June 28, 1975.	P7	$ .65
"The Garden of Feasibility," Gwyneth Cravens, *Harper's Magazine,* August, 1975	P8	$ .79
"Space Colonies and Energy Supply to the Earth," Gerard K. O'Neill, *Science,* December 5, 1975	P9	$ .65
"Wireless Power Transmission," John F. Mason, *Electronic Design,* December 6, 1975	P10	$ .44
"Colonies in Space," Ron Chernow, *Smithsonian,* February, 1976	P11	$ .86
"Moon Mines, Space Factories, and Colony L-5," Michael Guillen, *Science News,* August 21, 1976	P12	$ .44
"Engineering a Space Manufacturing Center," Gerard K. O'Neill, *Astronautics and Aeronautics,* October, 1976	P13	$ 1.00
"The Impact of Space Colonization on World Dynamics," J. Peter Vajk, *Technological Forecasting and Social Change,* 1976	P14	$ 2.38
Complete set of reprinted articles	CP15	$11.25

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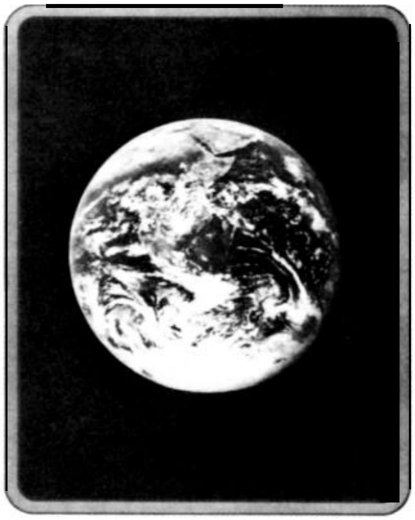

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WHAT IS THE L-5 SOCIETY?

“. . . I believe you are helping to pave the way for future developments that can profoundly affect mankind.”
—Senator Barry Goldwater

“I see a lot of similarities between the L-5 Society and the American Rocket Society of the 1930’s. In either case the groups were dealing with new concepts and ideas that had considerably more technical feasibility than was recognized by the technical community at large. The L-5 Society provides a forum for discussion and dissemination of ideas and concepts for the large scale human habitation of space that may occur in the future. These ideas are much broader in aspect than the technical concepts alone. The L-5 Society recognizes these broader aspects.”
—Gordon Woodcock, Solar Power Satellite Study Manager, Boeing Corporation

“Those of us primarily concerned with detailed research and with the integration of university, government, corporate and independent activity into a united program welcome the help of the L-5 Society, as a citizen’s organization publishing an informal, wide-ranging, and chatty newsmagazine and providing occasional grants particularly for student research activity.”
—Gerard K. O’Neill, Professor of Physics, Princeton University

“I am proud to be an L-5 member.”
—Robert A. Heinlein, author, ***Stranger in a Strange Land, The Moon is a Harsh Mistress***

“The L-5 Society aids the public understanding of the benefits of outer space in many scientific and legal areas, including its practical importance with respect to world peace.”
—Hon. Edward R. Finch, Jr., Chairman, American Bar Association Aerospace Law Committee

“I have read the Newsletter from the L-5 Society . . . with great interest. Space colonization as a future possibility for the peaceful use of outer space technology is gaining increasing attention from a number of member countries of the Outer Space Committee of the United Nations.”
—Peter Jankowitsch, Chairman, Outer Space Committee of the United Nations

“The L-5 Society manifests the pioneering spirit that brought people out of the caves and onto the moon. It is an indispensible source of information for all concerned with the future of the human species. Don’t miss it!”
—Barbara Marx Hubbard, author, ***The Hunger of Eve***

The L-5 Society is an international organization working to make space settlements a reality-by 1990!

L-5 members receive a monthly magazine, the *L-5 News,* which covers fast-breaking developments in space industrialization, satellite solar power, and space settlements. Pertinent books and articles are reviewed; calls for papers, conferences, requests for proposals, contract awards and job opportunities are reported. In-depth articles and interviews with major workers in the field explore the problems and promise of moving into the space environment on a large scale. And, perhaps most important, the *L-5 News* is a forum in which Society members raise and discuss what history may judge to be the most significant issues of our century.

The L-5 mail order service provides books, posters, postcards, slide shows and reprints of hard to locate articles, as well as pre-publication copies of papers and back issues of the *L-5 News.*

Special projects of the L-5 Society have included presentations at the “Limits to Growth ‘75” conference, the UN Conference on Habitat in 1976, and co-sponsorship of the AAS/AIAA Conference on the Industrialization of Space in 1977. The Society also provides small scale research grants to workers in the field.

Membership in the Society is $20 per year, $10 for students.

The L-5 Society is a nonprofit, tax-exempt organization under section 501(c)(3) of the Internal Revenue Code. Donors may deduct contributions to the L-5 Society as provided in section 170 of the Code.

L-5: A Place in Space

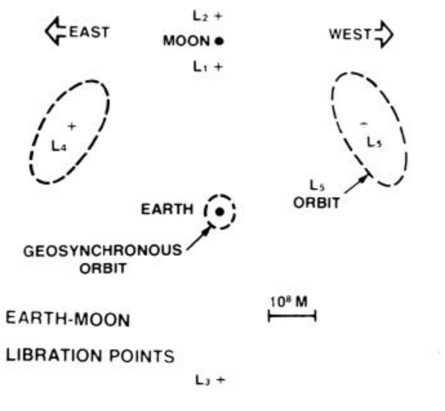
by T.A. Heppenheimer, author of ***Colonies in Space***

L-5 is the fifth Lagrangian Libration point. But what are libration points? They are locations where a spacecraft may be placed so as always to remain in the same position with respect to the Earth and the Moon.

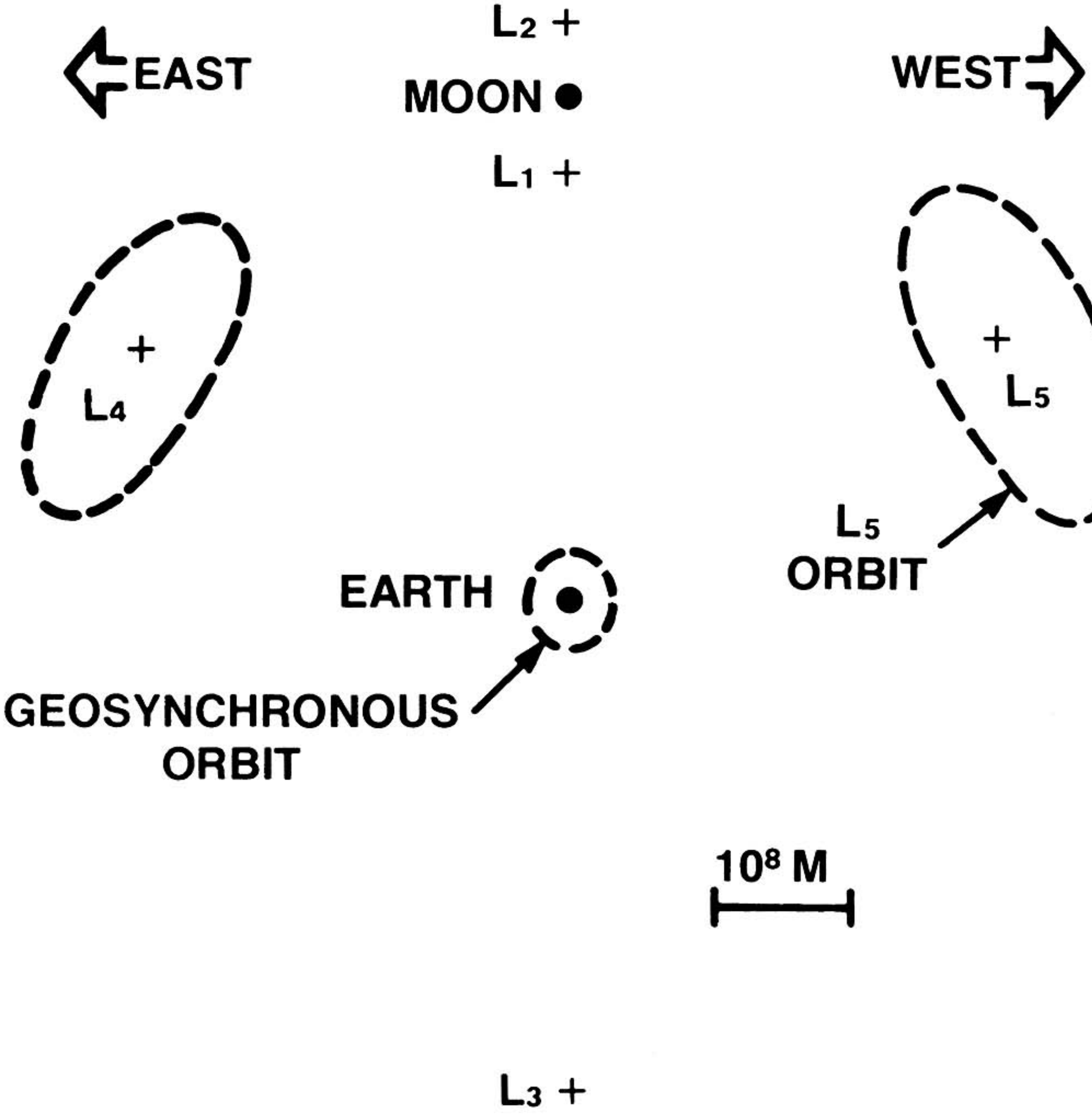
The French mathematician, Lagrange, in 1772, showed that there are five such points. Three of them lie on a line connecting the Earth and Moon; these are L-1, L-2, and L-3. They are unstable; a body placed there and moved slightly will tend to move away, though it will not usually crash directly onto the Earth or Moon. The other two are L-4 and L-5. They lie at equal distance from Earth and Moon, in the Moon’s orbit, thus forming equilateral triangles with Earth and Moon. The Sun is in the picture, and it disturbs the orbits of space&aft and colonies. It turns out (from an extremely messy calculation done only in 1968) that with the Sun in the picture, a colony could be placed not directly at L-4 or L-5, but rather in an orbit around one of these points. The orbit keeps the colony about 90,000 miles from its central libration point.

But what has people excited is not what orbit might be used, but rather what could be done there. Space industries in high Earth orbits could manufacture solar power satellites (SPS) from lunar or asteroidal resources. Each SPS could deliver twice as much low cost, environmentally safe energy to Earth, via microwaves, as the Grand Coulee dam, and forty five of them could meet the total present electrical power needs of the U.S.

This activity would create tens of thousands of jobs in space as well as on Earth within as short a time as 15 years, and getting tens of thousands of us living and working in space is the goal of the L-5 Society.



EARTH-MOON LIBRATION POINTS



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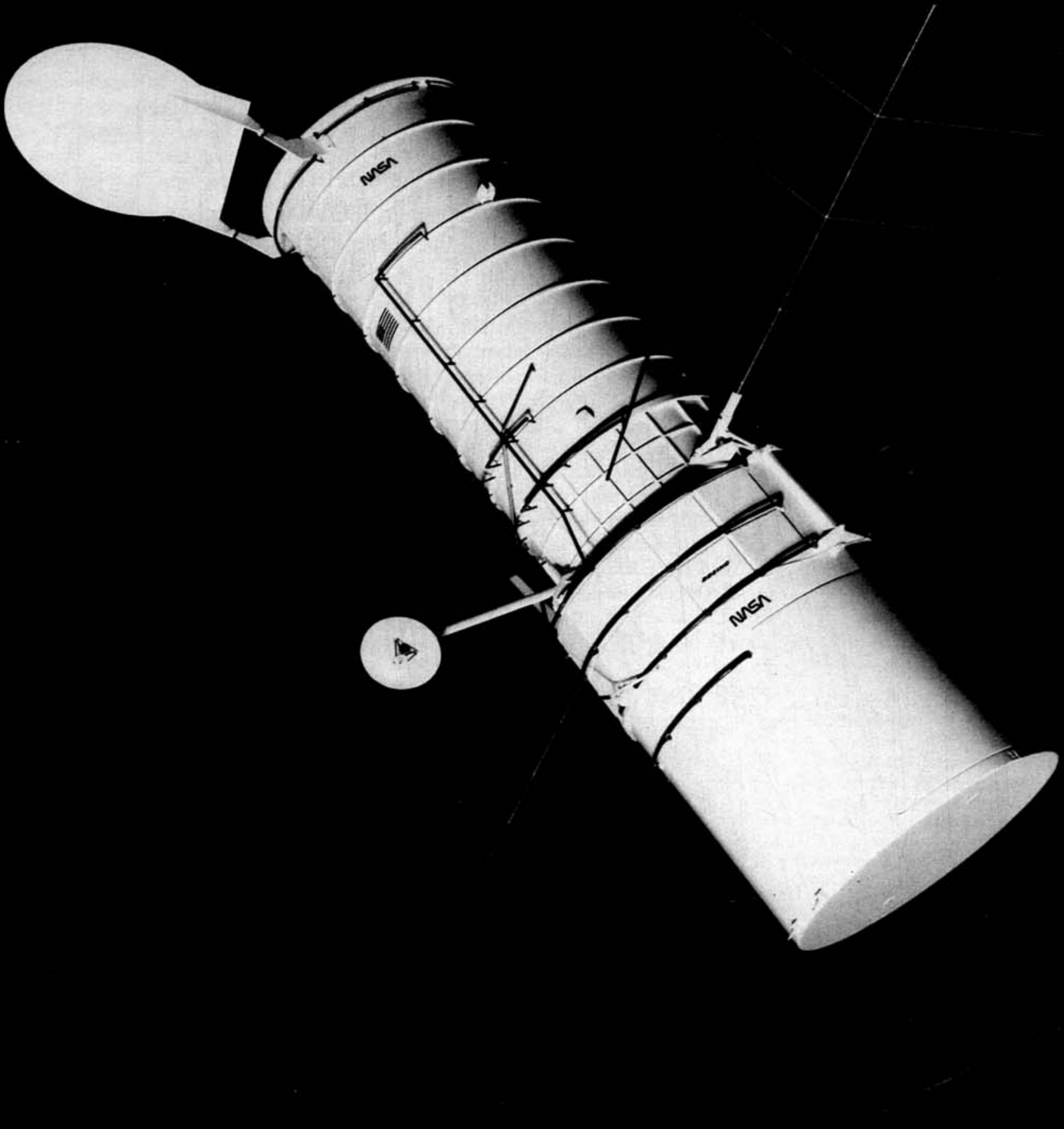

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VOL. 3 NUMBER 1 JANUARY 1978

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In this issue:

1 **OTA to Study SPS, Space Colonies?** Carolyn Henson reports on a Congressional resolution calling for a study of O'Neill's approach to building solar power satellites.

2 **House, Senate Plan Hearings**

News from the Opposition Proxmire and Carter science advisor Frank Press sound off on space colonies.

3 **Deep Seabed Mining: A Model for Extraterrestrial Resource Mining?** Keith Henson examines legislation in the mill on seabed mining.

4 **Because That's Where the Money Is** Marc Boone tells us how to get Congress to loosen up the purse strings.

5 **News from NASA, ESA**
  Space Factory Study
  ESA/NASA Summit Meeting
  ESA to Provide Space Telescope Components
  Shuttle Orbiter Tests Completed

8 **Astronaut Corps - Or Space Soldiers?** It looks like the shuttle pilots corps will consist of military test pilots - and disgruntled airline pilots aren't happy about it. Robin Snelson reports.

10 **Penthouse Slams OTRAG** If you thought Lutz Kayser had problems last month, you should see him now! Carolyn Henson reports.

11 **Earthport Update** Mark Frazier's dream is getting off the ground.

12 **Brown Foundation Funds SPS Work** Rice University gets a $100,000 grant.

13 **Bibliography Update**

16 **Conferences**

17 **Inside the L-5 Society**

19 **Letters**

Cover: the NASA/ESA space telescope. See related story page 5. (Photo courtesy Dr. Bachall, Princeton, University).

OTA to Study SPS, Space Colonies?

by Carolyn Henson

Veteran Washington space lobbyist Barbara Marx Hubbard is one person who isn't fazed by Carter's lack of interest in space. If one branch of the government seems unresponsive, her tactic is to turn to another: the U.S. House of Representatives and Senate.

With the assistance of several local L-5 chapters, in particular the Washington group, Hubbard organized a seminar on solar power satellites and space colonies for Congresspeople and their staffs. Held October 28 and 29 in the Rayburn Building, it featured Princeton professor Gerard K. O'Neill and Apollo-era NASA administrator Thomas O. Paine, as well as a constellation of other space researchers. Their message? If we choose to do so, we can establish cities in space producing satellite facilities which will provide abundant solar power to Earth by the early 90's.

Who heard that message? Representatives Dave Stockman (R-MI) and Barbara Mikulski (D-MD) attended, as well as House of Representatives staffers Rebecca Tidman for Dante Fascell (D-FL), Steve Kolterman for Richard Schulze (R-PA), Daren McRumel and Mary Beth Paladino for Richard Nolan (D-MN), Jean Marie McCarthy for Stan Lundine (D-NY), Ellen Burton for Joel Pritchard (R-WA), Bonnie J. Poore for Harold Johnson (D-CA), Morry B. Markowitz for Hamilton Fish Jr. (R-NY), Jane D. Woodlin and Gary R. Bachula for Bob Traxler (D-MI), Robert Wiekowski for Don Edwards (D-CA), Martin Wattenberg and Andrea Pamfilis for Pat Schroeder (D-CO), Jan Tavislan for Jim Johnson (R-CO), Guy Cavalo for Elliot Levitas (D-GA), Hal C. de Celly for Janice Whitten (D-MI), and Robin Weiss for Thomas Downey (D-NY). Tim Lynch for George Brown (D-CA), Paul Parshley and Bill Anderson represented the House Interior and Insular Affairs Committee (chaired by Morris Udall [D-AZ]), Darrell R. Branscome. Ezra D. Heitowitt, and James W. Spensley represented the House Science and Technology Committee (chaired by Olin Teague [D-TX]). The U.S. Senate was represented by Jacqueline Merson for Jacob Javits (R-NY), Costas Avrokotos for John Heinz (R-PA), and John G. Stewart and Allan Hoffman for the U.S. Senate Commerce Committee's Science, Technology, and Space Subcommittee (chaired by Adlai Stevenson [D-IL]). The Office of Technology Assessment, which provides the House and Senate at their request with in-depth analyses of technical and scientific issues was represented by Dennis Miller, Bill Mills, and Gretchen Kilsrud.

The upshot of Hubbard's seminar is House Concurrent Resolution 451, introduced by Olin Teague. (House Concurrent Resolution 447. introduced at the same time by Lindy Boggs [D-LA], Dave Stockman, and Barbara Mikulski, is identical to Teague's.) It calls for the Office of Technology Assessment (OTA) to "determine the feasibility, potential consequences, advantages, and disadvantages of developing as a national goal for the year 2000 the first manned structures in Space for the conversion of solar energy and other extra-terrestrial resources to the peaceable and practical use of human beings everywhere."

If passed, the resolution will initiate the first study of space colonies and solar power satellites ever conducted by OTA. If you would like a copy of the resolution, or to make comments, or request more information, write to Mikulski, Boggs, Stockman, or Teague, U.S. House of Representatives, Washington, D.C. 20515.

Note: Barbara Marx Hubbard is author of **The Hunger of Eve,** *an autobiography which includes fascinating tidbits from her activities as a Washington lobbyist. She is a Director and one of the major financial supporters of the L-5 Society.*

What is OTA? It is a research arm of the U.S. Senate and House of Representatives. Following are some details on OTA, lifted straight from the **Congressional Directory** *(available from the U.S. Government Printing Office, Washington, DC. Addresses below which don't include the city are in Washington, DC.)*

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House, Senate Plan Hearings

O'Neill, Hubbard to Testify

The House Science and Technology Committee Space Science and Applications Subcommittee will hold hearings titled "Future Space Programs" this winter. They are tentatively scheduled for Jan. 24, 25 and 26. Princeton physics professor Gerard K. O'Neill and space activist Barbara Marx Hubbard, among others, will testify. For more information, call committee staff member Darrel R. Branscome, 202/225-6371 or write to: Subcommittee on Space Science and Applications, U.S. House of Representatives, Washington, DC 20515.

The Senate Commerce, Science and Transportation Committee, Science, Technology and Space Subcommittee plans a hearing, "Long Term Space Policy" Feb. 7. It will be held in the form of a round table discussion by top researchers. The morning session will cover applications: space industries, solar power, etc. The afternoon will be devoted to space sciences: planetary probes, astronomical facilities, etc.

The speakers at the symposium have not yet been determined (at the time of the writing of this article). For more information, contact committee staffer Allan Hoffman, 202/224-5115 or write to the Subcommittee on Science, Technology and Space, U.S. Senate, Washington, DC 20510.

The public is encouraged to attend both the House and Senate space hearings. They will provide both information on what the researchers think we should do for our future space activities, and what Congress thinks should be done with the researchers' aspirations.

News from the Opposition

In a recent speech given before the Council of Scientific Society Presidents Dr. Frank Press, who also holds the position of Director of the Office of Science and Technology Policy in addition to Advisor to the President, announced that he and his staff are working to "enunciate a national space policy." While Dr. Press did not specify when such a policy would be formally presented for consideration by appropriate legislative committees, he did mention that the Earth applications project would be given top priority.

When asked if advanced projects, such as space settlements, would be included in the plan, Press responded, "You're talking about a $100 billion program . . . you won't see it in this century."

Despite such statements on the near-term impracticality of space settlements from the Administration and top NASA officials, the concept is enjoying increased grassroots support and mass media attention. In October, a non-profit organization called the Committee for the Future sponsored a two-day seminar on space settlements for members of Congress and their staffs. The program's message was that settlements of "ordinary" people could be living in space within 20 years and beaming solar electricity to Earth -- if Congress encouraged such a project to begin now.

Reprinted from FASST Tracks,
1785 Mass. Ave. NW,
Washington, DC 20036

The following letter was sent in by James Greer of Milwalkee, WI.

Dear Mr. Greer:

Thank you so much for your letter responding to my reaction to the 60 Minute L-5 by 95 space fantastic.

You make an excellent point about the need for further study with the possibility of using solar power stations to provide electrical power from space at a more economical rate than would occur from earth based power systems.

That makes sense. Potential benefits are clear and I certainly favor that kind of study.

What I do not favor is developing a program that, in my view, would cost hundreds of billions and perhaps trillions of dollars to place a relatively few people -- 10, 15 or 20 thousand -- in a space capsule. Not only would the capital cost be appalling, the annual operating cost would be outrageous.

This is something that might be done 10 or 20 thousand years from now. But for the next 30 or 40 years your proposal for solar power stations makes far more sense.

Sincerely,

William Proxmire,
U.S. Senate

Deep Sea Mining: A Model for Extraterrestrial Resource Mining?

by H. K. Henson

Many of us closely concerned with space industries and habitats are beginning to see private enterprise as our best hope for rapid developments. (Rapid in this context means before the end of the century!) A great many obstacles lie in the path of such an enterprise. Beyond the obvious technical ones are such factors as the sheer cost of an extra-terrestrial resources (ETR) project. Whether lunar materials or asteroids are used, the guesses center around 75 ± 25 billion. Another factor is the possibility of vigorous objections of the USSR to capitalism escaping the planet. Still another, which will retard acceptance of such entities as the staging company proposed by C. Basler, is the lack of a legal framework for a private ETR development company. Legal opinion is divided as to whether or not such a company could mine the moon, and if so, what should be the disposition of the products or profits created. A large part of the legal difficulty lies in the vagueness of the "common heritage of mankind" (was womankind left out?) wording of the 1967 Outer Space Treaty.

This kind of treaty language, as opposed to the old "devil take the hindmost" custom, is peculiar to the later half of the 20th Century. It is probably more a result of the larger powers agreeing not to squabble over something worthless than to altruism toward the developing countries. Antarctica, the deep seabed beyond the continental shelves, and outer space are subject to such agreements. However, advancing technology changes our opinion of "worthless." Political and legal strains then develop as people, be they socialist or capitalist, start thinking of how to exploit "new" resources to make their lives easier.

Deep seabed mining, after 15 years and $100 to $150 million of research, is at this point of commercial development. Several companies, including Kennecott and Deep Sea Ventures, are prepared to spend some $300 million each to get into the business of scooping up nodules containing manganese, nickel, copper and cobalt from under 3 miles of ocean.

Relevant legal events are the bogged down law of the sea conference and U.S. legislation, the Deep Seabed Hard Mineral Resources Act (HR3350), now wending its way through Congress. U.S. based L-5 members interested in a private investment approach may want to follow this legislation as its precedent would make passage of similar laws for ETR development much easier.

The following is quoted from House Report 95-588, part 1: (page 14)

PURPOSES

The purposes of the Deep Seabed Hard Mineral Resources Act are fourfold. First, it is intended to encourage and regulate the development of hard mineral resources from the deep ocean floor. However, it is clearly intended that the legislation only be an interim measure pending the adoption of a superseding international agreement that will be applicable to such activity and to which the United States becomes a party. Secondly, the legislation is designed to insure that the development is carried out in a manner that will protect the quality of the environment.

A third purpose is to encourage the successful negotiation of a comprehensive Law of the Sea Treaty that will legally establish the meaning of the phrase "common heritage of mankind." In an effort to show the good faith of the United States and its desire to work toward the legal establishment of the concept of the common heritage of mankind, assuming, of course, that a definition is established that is acceptable to the United States, the act proposes to establish a special fund, the proceeds of which are intended to be shared with the international community under the terms of an acceptable Law of the Sea Treaty binding on the United States. Finally, the act is designed to permit the continued development of the necessary technology for the expeditious development of hard mineral resources from the seabed.

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(page 20 & 21)

III. THE NEED FOR SECURITY OF TENURE

Such a provision, according to Mr. C. Thomas Houseman of the Chase Manhattan Bank, is an important prerequisite to obtain project financing. He stated in testimony before the Subcommittee on Oceanography that --

> in order for financial institutions to consider participating in such a venture, it will have to stand up under a critical evaluation of risk factors . . . A firm concession with security of tenure to a specific mine site would appear to me to be an absolute requirement for the project financing of an underseas mining venture -- without it, a lender could assume neither the reserve nor production risks.

It is extremely important to understand here that H.R. 3350 does not in any way provide property rights to the seabed to ocean miners. The provisions are entirely consistent with international law.

For licensees and permittees, H.R. 3350 merely provides assurance that other U.S. citizens or citizens of reciprocating nations will only operate within the mine site in which they are authorized to operate. As noted by' Mr. Houseman, this is an important provision to prospective mining companies and their investors. In addition, the security of tenure provision included in H.R. 3350 will facilitate environmental assessment and monitoring of mining operations.

• • •

An aspect peculiar to deep seabed mining is the design and construction of special equipment for mining and processing. These design and process specifications will be predicated upon specific mine site attributes including topography of the ocean floor, depth, ocean currents. weather conditions, and the size and composition of the nodules. There can be significant variance in this set of attributes depending on the location of the mine site. It is during the exploration phase of a deep seabed mining project that data are collected to determine mine site characteristics. According to a study conducted by the Department of the Interior, the exploration phase is expected to cost between $75 and $150 million.

Considering the degree of dependence of a deep seabed mining investment on a particular mine site, and the need from an environmental monitoring and assessment standpoint to have a defined area in which mining can occur, the committee recognizes the need for the establishment of a legal framework providing security of tenure to particular areas of the seabed for mining operations.

(pg 24 & 25)

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STATUS OF INTERNATIONAL LAW

I. EXISTING INTERNATIONAL LAW

Questions have been raised about whether the bill, which establishes a licensing and regulatory scheme for the development of the hard mineral resources of the deep seabed beyond the jurisdiction of any nation by U.S. citizens, would violate the generally recognized principles of international law. The committee is convinced that the bill does not violate customary international law and, in fact, is legal and proper under it. This conclusion is based on several premises.

The first and most important of these is the doctrine of *res nullius,* which means that resources are the property of no one, are subject to appropriation by anyone, and that ownership exists only after the resources are reduced to possession. Nodules, like fish, and oil and gas beyond the jurisdiction or control of any nation, clearly fall under this doctrine. Thus ocean mining is a freedom of the high seas which presently exists with or without domestic legislation. . .

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In its deliberations, the committee has not ignored the concept of the "common heritage of mankind." The United States supported the concept in the United Nations when it voted affirmatively in 1970 for United Nations General Assembly Resolution 2749 (xxv) which espoused the doctrine that the ocean resources beyond the jurisdiction of any nation belong to all mankind. However, it has consistently been the policy of the United States that the concept would be legally defined and clarified under the terms of a future comprehensive Law of the Sea Treaty. No such clarification has taken place thus far.

It is recognized that the developing countries contend that the concept prohibits the United States, or any other nation with the technological ability to do so, to develop these resources or reduce them to possession. However, the committee is convinced that the Resolution 2749 is neither binding on any nation at the present time, nor sufficiently defined to justify the conclusion that the taking of nodules under international law is not permissible at the present time. Therefore, this bill merely enacts a system for allocation of access among U.S. citizens and provides the procedures that must be followed by such U.S. citizens in the development of the nodules. It in no way asserts any territorial or sovereignty claim to the existing resources nor does it assert an exclusive right to remove the resources as against another nation or its citizens. Until an international agreement is ratified or custom changes the existing international doctrine or *res nullius* as it applies to deep seabed mining, such activity is permissible and a proper exercise of a freedom of the high seas under customary international law.

Copies of HR 95-588 are available from Congressman Murphy (D-NY), Suite 2187 Rayburn, Washington, D.C. 20515.

Because That's Where the Money Is

by Marc Boone

Why are so many L-5 people interested in lobbying the U.S. government? One reason is that is where the money is - our tax money. Also, even if the money needed for the large scale space projects so dear to our hearts can be raised privately, the government could still stymie the effort just by passing a law. Moreover, the opposition to the use and habitation of space, as exemplified by John Holt, has already been using all available political avenues to suppress the issues before they can be properly studied. We have a right as citizens to have a portion of the government budget spent on our interests; to do so we must make our views known.

Essential skills for lobbyists are common sense and the ability to empathize with people who might not immediately agree with your point of view (such as Senator Proxmire). These skills are needed in all aspects of lobbying, from writing a simple letter to mounting a complex campaign.

Knowledge is strength. You need knowledge on both the cause you are promoting and the audience you are trying to reach. The more you know about each, the better reception you will get. Having plenty of facts at the tip of your tongue is the best way to earn other people's respect and avoid being pigeonholed as just another space nut.

But be careful to be interesting as well as completely accurate. Use pictures and charts. Slide in jokes where relevant. If you are dull, the audience will be bored at best and at worst suspect you of dishonesty. If you can't help being dull, encourage someone who has a talent for keeping audiences awake to do the talking. You'll still have more than enough to keep you busy researching the issues for your friend who's doing the talking.

The audience can be divided into three groups: the representative you wish to influence, the media, and the public. If you work as a group, different members can specialize on different parts of the audience. The challenge is to make sure that the information you present and the people you're trying to reach are keyed to each other. Stress business statistics when talking to chambers of commerce; labor statistics to union groups; economic impact of SPS on third world nations to church groups; and ecological benefits to conservation groups.

When dealing with the press, remember their impact on public opinion. At all costs, do not alienate them. Remain courteous, friendly and uncritical even when your local newspaper editor is pouring salt into the knife wounds all over your back. Even when reporters and editors appear to be unfair, remember, they can always get much worse!

With the public and press it is usually pretty easy to know what their attitudes are. With Congresspeople, it is often much harder. If you don't know how your representative leans, just write a short, clear, courteous letter stating what you would like supported or voted on. Often, when there is no other input to a representative on an issue, one letter may change a vote. Writing a letter takes as much time as a cup of coffee and costs far less. Of course, the better the letter, the more impact it has. At the least, all mail gets counted; but a well written letter gets read.

Where can you get the information you need in order to be an effective lobbyist?

For an understanding of the concerns of environmentalists, Space Colonies, edited by the CoEvolution Quarterly's Stewart

Brand, is required reading. Some sources of information on Congress-folk are the Congressional Quarterly Almanac (CQ) which is compiled from Congressional Quarterly Weekly Reports. The CQ Almanac is a thorough review of the past year's activities in the U.S. Congress. It includes the yearly NASA budget fight, which usually runs two to six pages in length, and includes voting records and important speeches. For a few dollars you can copy the entire Congressional history of the NASA budget. The CQ Almanac is available in most libraries. Another source of information often available in libraries is the Ralph Nader Congress Project. These are fairly unbiased studies that run about 20 pages apiece on each member of Congress. They include information on their background, lifestyle, support, beliefs and voting record (including the Senate space shuttle votes).

The important thing in any lobbying effort is to generate the widest and most intelligent support possible, and to make sure your government is politely notified of it. If someone writes a good letter to each of their Congresspeople, and one to the President for good measure, fine. If a dozen or more people in the same district write intelligently to them, great. If it's a letter and/or a press release from some prominent community organization and they get the local newspaper to publish an articulate letter to the editor, that's fantastic. If you can get this orchestrated to all happen at the same time a crucial vote is coming up, you've probably won. If not this year, then maybe next.

With a little work, tact and patience we'll get to L-5 yet!

Royal Observer of Space Shuttle -- His Royal Highness, Prince Charles of Great Britain with David Scott (former director of the Dryden Space Flight Center) to his left and Lee Sherer, director of the Kennedy Space Center at far left. The occasion was the fifth free flight of the Space Shuttle orbiter at the Dryden center, Oct. 26, 1977.

News from NASA, ESA

Space Factory Study

by Carolyn Henson

Moon mines, space factories, Pittsburg in the sky -- are these in our future? Stan Sadin at NASA Headquarters, saying he wants a "cold, calculating analysis," is sponsoring a four part study which may answer that question.

The Lunar and Planetary Sciences Division of Johnson Space Center, in conjunction with Houston's Lunar Science Institute and Universities Space Research Association will study the mining of lunar ores and their conversion to primary metals. Dr. Richard J. Williams at Johnson Space Center will manage the study.

Once you've got ingots of metal in space, what are they good for? George F. von Tiesenhausen at Marshall Space Flight Center is managing the portion of the study which considers how to turn raw metals into wave guides, electrical conductors, silicon cells, beams, etc. Parameters such as throughput and investment needed will be considered.

How do you move people, supplies and products around in space and on and off the lunar surface? Fred Teren at Lewis Research Center will identify advanced propulsion systems which may be available. Gerard O'Neill's mass driver using pelletized shuttle tanks for reaction mass, and a metallic oxygen rocket using lunar refined fuel will be considered, as well as more conventional rockets using fuel shipped from Earth.

The fourth part of the study will tie together the whole "space factory" package. Study manager Earle Crum of Johnson Space Center will establish three alternate futures. One assumes a large scale solar power satellite (SPS) construction program. The second assumes less activity in space: a public service platform, large communications satellites, etc. but no SPS. The third alternate future assumes an exceedingly small presence in space.

Then a 'best case" analysis will be made of how these futures can be accomplished using only system elements of Earth origin. Next the assumption is made that only lunar derived oxygen is available as a result of the moon mine operation, and its impact on all three alternate futures is studied. Then Crum's team will assume that mass drivers using spent shuttle tanks for reaction mass and/or metallic oxygen rockets using fuel of entirely lunar origin are available. Earle Crum hopes to thereby define what level of space activities and what transportation systems are necessary in order to justify "space factories."

The four parts of the study have been put up for bid; proposals were received by Dec. 23. Sometime in late January or early February the winning proposals will be announced.

Those of us who hope to get jobs in those space factories someday will be watching this four part study, a study which could make or break our plans for the future.

ESA/NASA Summit

In early October, Administrator Dr. Robert A. Frosch, concluded a week-long, highly successful first visit to Europe as Administrator. At a meeting with the Director General of the European Space Agency in Paris, the annual Spacelab program review was concluded. The $600 million European Spacelab development program was found to be proceeding well and on schedule for a 1979 delivery to NASA of the first Spacelab units, to be flown in 1980.

After visiting ESA headquarters in Paris, Frosch went to Holland, where he signed a cooperative agreement for the Infrared Astronomy Satellite project with Dutch space officials. IRAS will conduct the first astronomical survey of the entire sky at those infrared wavelengths undetectable by Earth-based telescopes because of the obscuring effects of the atmosphere.

Scheduled for launch in 1981, the Earth-orbiting observatory will employ a large infrared telescope furnished by the United States, a spacecraft built by the Netherlands, and a ground operations facility supplied by the United Kingdom. All three nations are participating in providing the scientific instrumentation of the satellite and in the observation program.

Frosch then visited Germany, where he signed a cooperative agreement on the Jupiter Orbiter Probe with German space officials. This planetary exploration mission, scheduled for flight in early 1982, will be the first planetary spacecraft to be carried aboard the Space Shuttle.

The probe is designed to conduct the most detailed scientific investigation of Jupiter and its environment and moons, including the first direct measurements of the atmosphere of the planet. The mission is composed of an orbiter that will circle the planet for at least 20 months and a probe that will plunge deep into Jupiter's atmosphere. Under the agreement, Germany will provide a retro propulsion module designed for injection of the orbiter probe spacecraft into orbit around Jupiter. It also will provide not only selected scientific instruments for integration into the scientific payload, but the services of selected scientific investigators.

The several new cooperative agreements will result in total European expenditures of some $180 million in the three space science programs over the next few years.

Senior NASA officials accompanying Frosch on all or some of his visits were: Dr. Walter Williams, NASA's chief engineer; Arnold W. Frutkin, assistant administrator for international affairs; Walter P. Murphy, NASA's European representative Douglas R. Lord, NASA director of the Spacelab program; and Richard J. H. Barnes, director for international planning and programs, office of international affairs.

ESA to Provide Space Telescope Components

The European Space Agency has signed an agreement with NASA for participation in the space agency's 1983 space telescope mission. A memorandum of understanding was signed on Oct. 7 in Paris by Dr. Robert A. Frosch. NASA Administrator, and Roy Gibson, Director of ESA.

Scheduled to be carried into Earth orbit by NASA's Space Shuttle, the space observatory will be used to study the universe with the highest possible resolution.

Under the agreement, ESA will provide a major scientific instrument and a spacecraft subsystem, participate in the in-orbit operation and maintenance of the telescope, and arrange for participation of ESA-sponsored European astronomers in the observation programs.

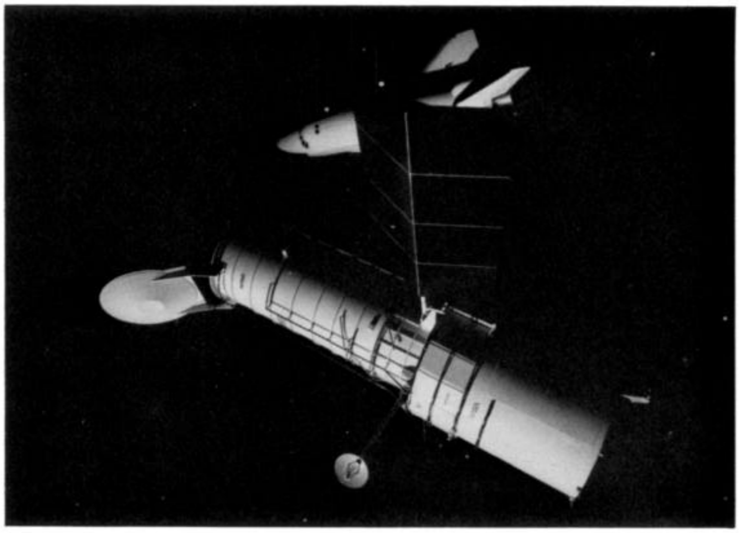
The scientific instrument to be provided by ESA is called the "faint object camera" to be used for high resolution imagery in the ultraviolet, visual and near infrared portions of the spectrum; the spacecraft system to be contributed is the solar array, to provide all power for the observatory.

The 2.4-meter diameter space telescope will be capable of accommodating up to five different instruments at its focal plane. It will weigh about 9,070 kilograms and will orbit the Earth at an altitude of about 500 kilometers above the obscuring effects of the atmosphere. Once placed in orbit, it will be operated remotely from the ground but will be designed to allow for maintenance and the change of instruments by a space-suited astronaut. It will be retrievable by the Space Shuttle for return to Earth for extensive overhaul and subsequent re-launch. These features should allow the space telescope to serve as an in-space astronomical observatory for more than a decade.

The space telescope is expected to help scientists to solve some of the mysteries relating to the structure, origin, evolution and energy processes of the universe -- processes that defy solutions through use of observatories below the obscuring veil of Earth's atmosphere. The space telescope should allow astronomers to observe some 350 times the volume of space than can be seen now with the largest ground-based telescope.

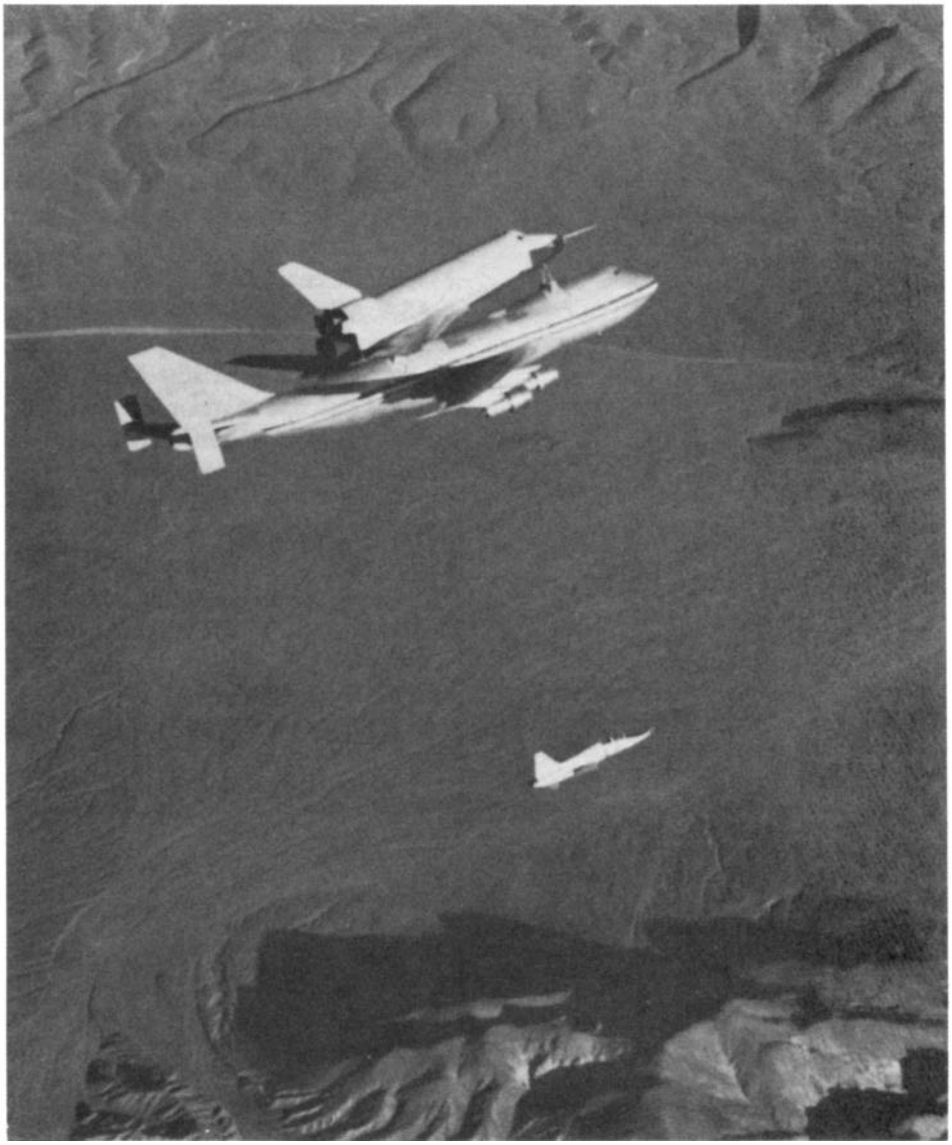
NASA's Marshall Space Flight Center will have overall management responsibility for the space telescope. NASA's Goddard Space Flight Center will be responsible for managing the development of the scientific instruments and for the operational aspects of the observatory. The European effort will be managed by the European Space Technology Center at Noordwijk in the Netherlands.

Historic International Agreement Reached -- At the Paris headquarters of the European Space Agency, NASA Administrator Dr. Robert A. Frosch and ESA Administrator General Roy Gibson signed a memorandum of understanding stating the terms for cooperation between the two agencies in the NASA Space Telescope Program. Seated at Dr. Frosch's right is H. Kantenecker, of ESA, at his left Gibson. Observers standing behind the three men are not identified.



Eye of the Gods: the space telescope. planned to go into operation in 1983. will be able to observe 350 times the volume of space visible to even the best of ground-based instruments. Some scientists believe it will be able to observe the birth of the Universe.

Shuttle Orbiter Tests Completed



Historic Moment in Space Shuttle Testing -- The fifth and final free-fall test of the Space Shuttle orbiter took place Oct. 27 at the Dryden Space Flight Center. This photograph shows the 747 and orbiter just before separation took place, with one of six chase planes in view. Below is the Mohave Desert.

The world watched the beginning of a dream come true as the U.S. Space Shuttle moved from theory to reality in a series of trials during the past several months. Hundreds of NASA and contractor people formed a team that made the daring and complex venture seem almost commonplace as test after successful test was carried out.

Astronauts Fred W. Haise and C. Cordon Fullerton made a bouncy but successful landing of the Space Shuttle orbiter on its fifth and final free-fall flight test in late October on a hard surface runway at Edwards Air Force Base.

In their straight-in approach, which took only two minutes, Haise and Fullerton aimed for a touchdown about a third of the way down the runway and planned to bring the craft to a stop at the 3,000-m mark. That would be similar to landings of a Shuttle returning from orbit to the runway of the Kennedy Space Center. The pilots overshot their landing point by more than 300 m, but managed to steady the craft and stop it well before the end of the runway.

The *Enterprise* bounced back into the air after first hitting the runway and dipped a wing noticeably. It bounced at least two more times before settling down on the runway and rolling to a stop.

During a postflight press conference held at the Dryden Space Flight Center, Haise attributed the rough landing to higher-than-expected speeds during the final seconds, saying he had to “force” the *Enterprise* down onto the runway.

Chief of the Shuttle approach and landing tests Donald K. Slayton said at the same conference: “We have accomplished all the objectives we set out to accomplish. I’m very happy with the way it’s progressed.”

This was the first landing on a hard-surface runway and the second time the orbiter flew without its tailcone. The tailcone provided smooth airflow and reduced drag of the 747-orbiter combination during its climb to separation altitude. But orbiter astronauts reported the level as acceptable without its aid although the 747 tail surfaces were subjected to buffeting.

Inside the 747, pilot Fulton said the buffeting was not as much as anticipated. The damper located in the nose section of the jumbo jet was turned on to alleviate the lateral vibration caused by buffeting around the 747 tail. The damper can best be described as a 450-m, spring-loaded weight, and it did improve the ride up front.

In four additional tests that took place in November at the Dryden center, the mated aircraft underwent ferry-configuration flights. Then it was back to the barn, at Dryden until March, when the paired craft will fly to Huntsville, Ala. Marshall Space Flight Center personnel, under the direction of project manager Robert Lindstrom, will then subject the orbiter to a six-month-long series of ground vibration tests with rocket boosters and external tank attached.

In all interim between the final tests and delivery to Alabama, members of the Dryden team will continue to work on the orbiter, rewiring its electronics and completing other chores to ready the spacecraft for the next set of grueling trials, doing their utmost to prepare the *Enterprise* for additional successes as testing at Marshall continues.

Astronaut Corps - Or Space Soldiers?

by Robin Snelson

Bill Good is a big supporter of the space program, so he doesn’t like to have to make trouble for NASA. It’s just that he wants to save the space agency from rekindling public disaffection and international suspicion. He is considering filing an injunction under the Civil Rights Act to stop NASA from hiring a new cadre of astronauts. All in the best interest of NASA’s image, you understand. (NASA has rescheduled the new astronaut selection announcement for sometime in January because Dr. Frosch is too busy with budgetary matters to finalize the decisions of the JSC selection board.)

Braniff pilot and New York University business student Bill Good is glad NASA is hiring astronauts again because he’d like to be one himself. He says he first decided he wanted to be an astronaut in the early 1960’s when he was a sophomore in Vienna because, “I noticed the Europeans were most impressed by two things about America--the Kennedy presidency and the space program.”

Good believes the space program still has the potential to transcend nationalism and spark international cooperative efforts.

But if NASA ends up with an astronaut corps dominated by active duty military men again, and that’s the way it’s shaping up right now, Good thinks the prospects for international cooperation are on shaky ground.

He also wonders how the American public will react to another group of astronauts who work for the Department of Defense.

In the early days of manned space flight NASA insisted on astronauts who had test pilot experience in high performance jet aircraft. The only people who get that kind of experience are those who come up through the military system ‘and get into test pilot school. That’s why the first astronauts were all white males on active military duty.

Later the National Academy of Sciences lobbied for scientist astronauts and screened candidates for NASA. The agency subsequently hired several scientists to fly into space. Coincidentally, they too were all white males.

This time NASA is hiring two kinds of astronauts to work through 1985 -- pilots and mission specialists. Women and minority candidates were encouraged to apply.

Since August, 128 finalists for mission specialist positions were interviewed at Johnson Space Center in Houston. Candidates for the scientist astronaut jobs are a diverse group--research scientists, professors, students, doctors, astronomers, government employees, some military people. That group of 128 includes 21 women, six blacks, three Hispanics, two orientals and one American Indian.

There were 1,261 applicants for the pilot positions. According to Duane Ross in the astronaut recruiting office at Johnson, almost half the pilot applicants didn’t meet basic qualifications like 1,000 hours of first pilot jet time and advanced science or math degrees.

But 127 of those pilot applicants came to NASA recommended by branches of the armed forces. Among 80 finalists interviewed for the pilot jobs, only four are not active duty military men from that prescreened group. Two of the four civilian finalists work for the Federal Aviation Administration, the other two work for NASA. All have completed or are currently enrolled in test pilot school. The pilot finalists consist of 77 white males and three black males. None are airline pilots.

Bill Good wants to know why no pilots from the private sector made the first cut. Obviously he has a vested interest in NASA’s answer, but his question is an interesting one.

The official NASA reply is that jet test pilot experience is a preferred qualification for astronauts who will fly the space shuttle.

But Good and others question the wisdom of that particular requirement. Is test pilot experience a reasonable criteria for operation of the space shuttle, the vehicle NASA has been calling the “space truck” the space craft that is supposed to usher in the commercial era of the space age?

For one thing, the shuttle ‘will be outfitted with automatic systems so sophisticated that it can actually be landed without a pilot, if necessary, by ground control.

And if trips to earth orbit become as routine as NASA says they will -- on the order of 50 to 60 cargo-ferrying round trips per year by the mid-80’s -- do all the space shuttle pilots really need experimental aircraft proficiency? Does a civilian transport system which is seeking commercial customers in both domestic and foreign industry really need specialized jet jockeys on military payroll to drive its “space trucks”?

Wouldn’t some commercial pilots be able to do the job?

Bill Good thinks it’s a clear case of discrimination against pilots from the private sector. More importantly, because no women and few minorities have graduated from military test pilot schools, the very nature of that criteria excludes certain groups from consideration.

Bill Good is white, male and an ex-Marine pilot who flew close support for ground troops on his Vietnam tour. At age 31, he has logged over 9,000 hours of flying time and his computer expertise would be a valuable skill for a pilot astronaut, since the space shuttle flies with the aid of complex computers.

But there is no law which guarantees equal employment opportunity for private sector people in a federal program.

Houston lawyer and aerospace specialist Arthur Dula says, “If there is anything about which NASA has almost unlimited discretion, it *is* the selection of pilot astronauts for the shuttle.” He doesn’trule out a challenge to NASA’s decision, but he points out that suing a big federal agency is a terribly expensive and drawn out operation.

“The courts are very reluctant to review this kind of case. In an area where the agency is assumed to have special expertise, the court will usually leave this kind of highly technical judgement to the agency.”

However, if any of NASA’s selection criteria are arbitrary and not really related to what the job requires, and if those criteria have the effect of discriminating on the basis of race, sex, creed, etc., the court might decide to generate a lot of paper-

Airline Pilots demand shuttle jobs: Braniff pilot Bill Good and American Airlines pilot Angela Masson hope someday to be flying a route into space. Continental is also getting into the act, at least at the fantasy level, as this airbrush retouch of a shuttle picture demonstrates.

work for NASA by ordering the agency to justify those criteria.

If anybody succeeds in halting NASA's selection process at this late hour, it will likely be under the Civil Rights Act or specific equal opportunity regulations within the space agency. And since Bill Good hasn't been the victim of discrimination on the basis of sex, race, creed or color, his latest tactic is to find other pilot astronaut applicants who can argue that point.

NASA won't release the names of applicants who were turneddown, but Bill Good has found at least one who is interested in taking NASA to task for the test pilot requirement.

Angela Masson is an American Airlines pilot with 3,500 hours flying time, two masters degrees and a Ph.D. Her doctoral dissertation was a study on the exclusion of women from pilot duty in the military, and the resultant barriers for women in the airline industry and, ultimately, as astronauts.

At the time of this writing it remains to be seen if Good and Masson can marshal1 the financial resources necessary to seek a restraining order against NASA's astronaut selection. But the question raised by both is an important one: Is it in the best interest of the civilian space program to have an astronaut corps dominated by pilots on active duty for the military? Is the test pilot school requirement a valid selection criteria?

A former scientist astronaut, now resigned from NASA, is blunt about the astronaut selection board's military preferences. "The problem is how deeply entrenched the old-boy network is within NASA. It's like a private fraternity of military pilot astronauts--and they want to keep it that way."

Penthouse Slams OTRAG

by Carolyn Henson

Another voice has joined the chorus denouncing the private West German rocket company OTRAG. In a press conference held Dec. 15th, Penthouse magazine announced that their March issue will feature Tad Szulc's expose of U.S./German collusion to use OTRAG and its Zaire facilities as a blind for cruise missile development.

Szulc asserts that the German government, apparently in order to circumvent the 1954 Treaty of Brussels, which forbids the development of missiles on German soil, has secretly funded OTRAG's activities in Zaire at $50 million per year. He adds that the U.S. has agreed to supply guidance systems for the German cruise missiles,

Szulc is hardly the first to come to the attack. For several months the Soviet press has been raising hell over OTRAG, and cruise missiles are high on their agenda of fears. Even though 32 years have passed since the end of World War II, the Soviet press remains hypersensitive to German activities. A veteran U.S.S.R. space program observer Jim Oberg notes, "The Russians have been beating on the same drum for 30 years. Sometimes it's a new tune -- OTRAG's one -- but it's still the same drum."

It is easy to dismiss the Soviet flap as just another episode of anti-Nazi hysteria. But why would Penthouse, which has never been particularly concerned over the "Teutonic menace", join OTRAG's chorus of critics? Is there more to the story than recycled Pravda clippings?

A top U.S. NATO Alliance official states that "there is just no rational reason" for the U.S. to develop cruise missiles through a West German blind. Although ongoing SALT negotiations include a protocol restricting the deployment of cruise missiles, development and testing is another matter. He points out that "We are quite capable of testing in our own territory. Why we would have to go to Zaire is beyond me." The official U.S. diplomatic stance is a flat denial of the Penthouse and Pravda stories: "There is absolutely no substance to these allegations."

Being forbidden by treaty to develop missiles, the West German government does have a motive to use OTRAG as a front. But is OTRAG even capable of developing cruise missiles? "It would make more sense for the Germans to use a jet aircraft company" asserts one DOD observer. Cruise missiles fly long distances at low elevations, so it is necessary for them to use airbreathing engines. U.S. cruise missile research is baselining turbofan jet engines attached to an airframe. OTRAG, on the other hand, is developing direct ascent rocket engines.

The blaze of publicity which OTRAG has sought and succeeded only too well in receiving is another contraindication of secret weapons research. Why do they pass out pictures and press releases and advertise the existence of their African base if they rely on secret weapons funding for their livelihood?

One NASA observer admits that the enormous size of their test range is suspicious. "Why on Earth do they need 100,000 square kilometers?" A block of land 100 km square could hide a great deal. OTRAG asserts they need the area. To rephrase an old truism, whatever goes up but does not achieve orbit must come down, and they are not anxious for one of their stray boosters to flatten a village.

One way OTRAG's protestations of innocence could be checked out is by inspecting Landsat photos of the area. A check between the U.S. Federal Aviation Administration's records of known airstrips in the Manomo, North of Shaba area and the Landsat observations would detect any secret airstrips. It is believed that ground transportation in the area is sufficiently poor that an airstrip would be an essential adjunct of a secret weapons facility. (Landsat photos can be bought by both U.S. and foreign citizens from EROS Data Center, Dept. of the Interior, Sioux Falls, South Dakota.)

In the meantime, rumor has it that OTRAG's innovative booster research has ground to a halt due to lack of funds. It would be ironic if OTRAG's publicity efforts, apparently designed to attract new investors and public sympathy, have succeeded only in making them the villain of both the Soviet and U.S. media.

Earthport Update

by Mark Frazier

Fears of secret military use of space launch facilities are on the rise. Mark Frazier's planned international space port open *to all who wish to use its facilities or to monitor other user's activities may be a step toward easing these tensions.*

After several quiet months, the Earthport project has encouraging news to report. Our financial situation has improved greatly. Thanks to the generosity of a New York philanthropist, we are now moving ahead in a variety of areas.

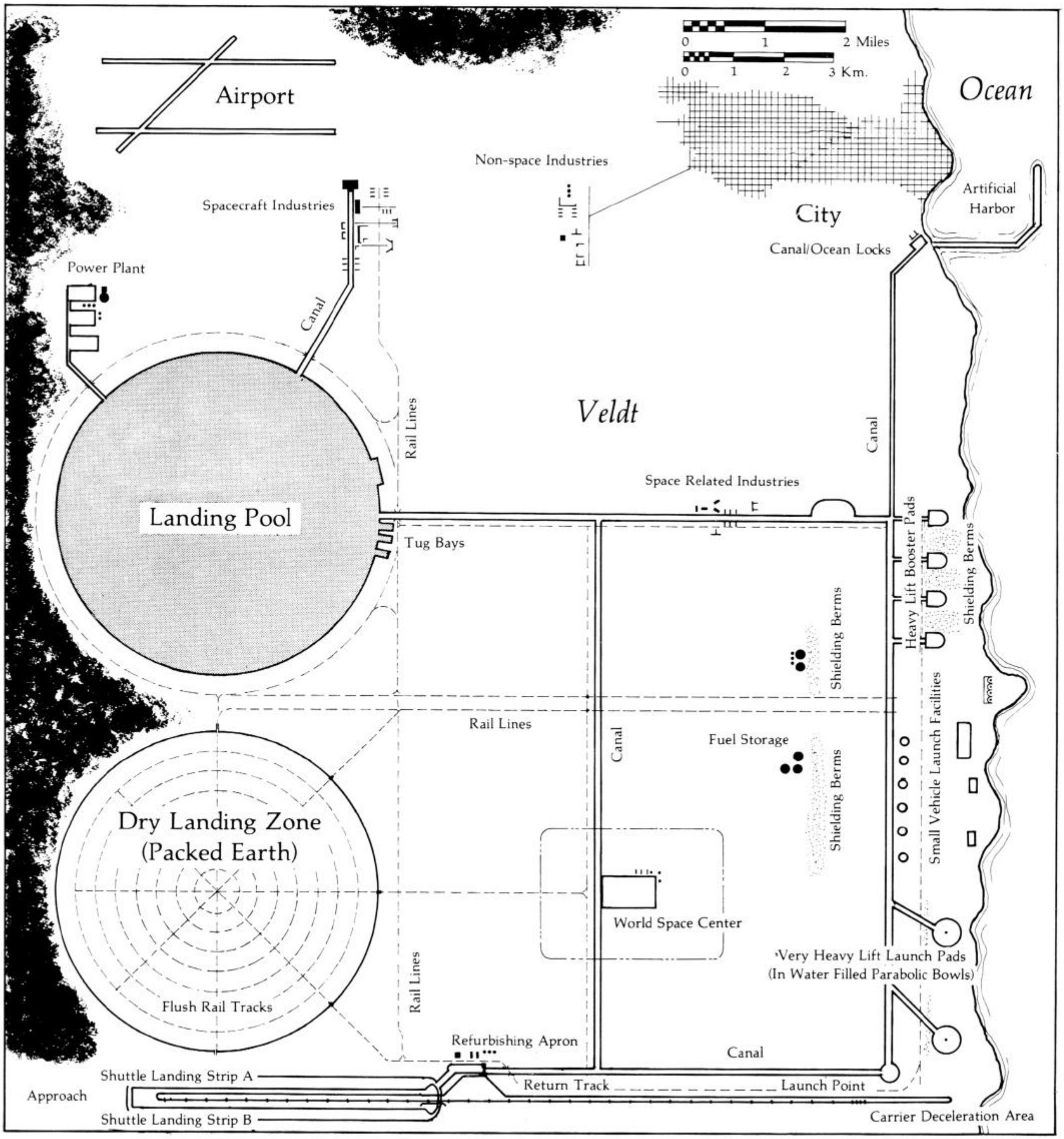
1. Interest by equatorial countries. To date, officials of five equatorial governments have expressed a desire to have an Earthport or Earthport tracking facilities considered for their countries. Formal letters of interest have been received from the Pacific island of Nauru, a wealthy equatorial nation, and the government of Rwanda in Africa. Similar letters are expected soon from Kenya, Surinam, and perhaps Colombia, as a result of meetings with their United Nations representatives.

2. New participants. The Earthport project welcomes a number of new members. In the past few weeks, Robert Heinlein and Buckminster Fuller have agreed to join the advisory board. Other new advisors include Barbara Marx Hubbard, of the Committee for the Future; Marcel Barrere, president of the International Astronautical Federation; and Ed Finch, chairman of the aerospace law committee of the American Bar Association. While we are delighted with the new advisors, we regret the loss of Arthur C. Clarke, whose retirement has prompted him to disengage from a wide range of space activities. In an otherwise most enjoyable meeting last October in Washington, Clarke told Earthport study director Mark Frazier that he would give Earthport materials to his longtime friend the prime minister of Sri Lanka, who is an advocate of free trade zones in the equatorial nation.

3. Leasing projections. Professor Alvin Rabushka, a senior fellow of the Hoover Institution at Stanford and a specialist in freeports, has prepared an estimate of rental income at a 200-square-mile free trade zone/space launch center. Assuming that only half of the area would be ultimately leased, annual revenues would amount to $373 million, at rates no higher for land than in existing free trade zones.

Preliminary Earthport Design

(To accomodate a wide range of future as well as present launch providers, an Earthport would have protected sites for heavy lift launch vehicles, and dry and wet recovery areas).



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Earthport would therefore generate substantial sums for payment to the host country, and for administration of the site. An estimated $100 to $125 million per year would also be set aside for a World Space Center, to subsidize use by developing countries of Earthport - based commercial launch providers. Copies of Rabushka's Leasing Income at an International Space Freeport are available from the Sabre Foundation.

4. International base. After a meeting of seven key Earthport study participants in Santa Barbara on December I, a decision was made to incorporate a non-profit "Earthport Authority" in Austria. The move reflects a desire to give the project a wider international base, and is a prelude to a world-wide conference on Earthport to be held in Vienna within the next 16 months.

5. Freeport Design Committee. Beginning in January, the Freeport Design Committee will begin preparation of a report on approaches for creating a prosperous international launch center. Historical research on free trade zones will be conducted by Earthport director Mark Frazier, in conjunction with his graduate studies in international relations at the University of California, Santa Barbara. Professor Alvin Rabushka, chairman of the Freeport Design Committee, will write the sections of the report dealing with contractual resolution of disputes and provision of services. Technical aspects will be dealt with by Dr. Michel Bader of the Ames Research Center in Palo Alto, who is one of several high-ranking NASA officials exploring the international launch center concept.

6. Publicity. Astronautics and Aeronautics, a leading aerospace magazine, has accepted an article on Earthport and private launch providers for a forthcoming issue. Former astronaut Dr. Philip Chapman, of Arthur D. Little, is co-authoring a longer and more technical treatment of the Earthport concept with Mark Frazier. The article will be adapted from a paper delivered by Frazier in October to the American Astronautical Society's conference in San Francisco on space industrialization. The winner of Playboy's 1976 nonfiction writing award, Jim Davidson, has been asked by the magazine to submit a proposal for an article on Earthport.

7. Corporate interest. Earthport advisor James Hagler, of the International Business Council, has agreed to arrange a mailing about the project to the organization, which consists of long-range planners for 50 multinational corporations. The mailing will explain the potential benefits to business of an international free trade zone. Hagler, who has been instrumental in the creation of two free trade zones in the United States, has also found support for the concept by foreign business executives. Other organizations whose officials have expressed a strong interest in the Earthport project in recent weeks include the World Trade Centers Association, and World Peace Through Law.

8. New Materials. A color, 15 page brochure has replaced the initial pamphlet describing the advantages of an international space freeport. In coming weeks, by arrangement with the Minneapolis-based Foundation Institute, the Earthport project will produce a new document on the benefits of an Earthport to industry. A fund raising prospectus will also be made available before February 1, the date of the next meeting of Earthport study group leaders in Santa Barbara.

Please call Mark Frazier at 805/965-7947, or write the Sabre Foundation, 221 West Carrillo Street, Santa Barbara, California, 93101, if you desire further information.

EXPERIMENTAL MODEL OF A SPACE SETTLEMENT

At the Institute of Biomedical Problems, USSR Public Health Ministry, Doctor of Medical Sciences Ye. Ya. Shepelev has completed a 1½-month experiment of human existence in a closed ecological system -- a miniature model of a future space settlement.

The hermetically closed space contains a greenhouse with allotments to grow wheat, cabbage, peas, beets, and carrots. Before the experiment, the plants were grown on a schedule to the stage when they could be harvested each week of the experimental period. They provided food and oxygen and consumed the carbon dioxide and minerals regenerated by microorganisms in fermenters from human waste.

The assortment of plants was such that, with one man in the system, a full balance was achieved without any additional physico-chemical equipment for air purification. However, when after one month of operation a second man was brought into the system it became necessary to connect the "Siren" ("Lilac") -- an additional biological system -- a chlorella-growing installation.

Dr. Shepelev describes the experimental model as simplified, since it does not include fauna representatives; he plans to eliminate this restriction in future experiments.

The water cycle was self-sufficient, although it required a severe restriction -- the complete exclusion of detergents and soap, demonstrating the sensitivity of the biosphere to certain man-made pollutants.

Reprinted from Pravda, *March 18, 1977, p. 6.*

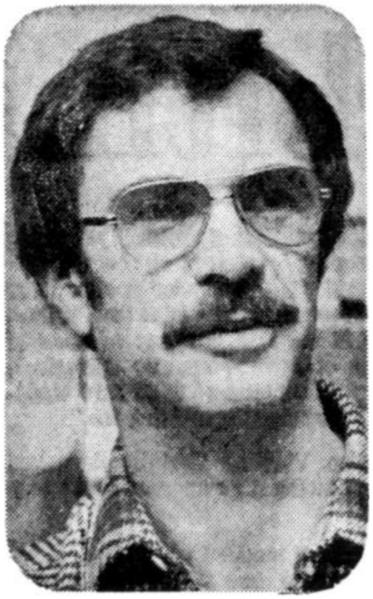
Brown Foundation Funds SPS Work

Rice University in Houston, Texas, has received a $100,000 grant from the Brown Foundation to study solar power satellites (SPS). Rice physics professor John W. Freeman, Jr., who is the study director, says "What we want is to make certain there are no shortstoppers. We want to make sure there are no problems so impassable the whole concept has to be thrown out."

Freeman reports that the work will cover:

- Energy conversion techniques on the satellite.
- Effects of cosmic rays on the satellites and the crews working on them.
- Effects of the satellite on the Earth's magnetosphere and ionosphere.
- Microwave antenna and receiving station rectenna designs.
- Effects of lightning on the rectenna.
- Alterations in Earth's heat balance due to the added energy input from SPS.
- Economic impact of SPS, including what the effect will be if the program is not undertaken.
- National and international social, political, legal and implementation aspects of SPS.
- Environmental impact.

Freeman adds that if Rice can locate an additional $100,000 by February, the Brown Foundation will provide another $100,000. The Brown Foundation is funded by Brown and Root, an industrial construction firm.



Study director John W. Freeman, Jr.

I'm writing in regards to the review of my book *Time Out For Tomorrow* that appeared in your September issue of L-5 News as reviewed by Conrad Schneiker. I found his review to be honest and forthright and very interesting. I particularly agree that we covered many of the topics too lightly. Of course, this was intentional. The book has been used to a great extent in schools as a primer for future living and the study of value systems. However, for a technical group as the L-5 certainly tends to be, the book is a little bit light in the technical area. We are trying to correct that problem in the next book, *Time Out For Tomorrow - Volume* 2, which will focus extensively on man's future in space. It is also an optimistic sketch of what tomorrow will bring, but dealing much more with what we will be able to do once we get outside the atmosphere of Earth.

Norm Avery
Penrose, CO

A mind-boggling, yet realistic view of the future is presented in *Time Out For Tomorrow* by Norman Avery. The quality paperback has just been released by T.H.A.R. Institute of Raynesford, Montana.

The concepts of future living outlined in *Time Out For Tomorrow* are not the result of crystal ball gazing, nor are they plucked from the air by an over-active imagination. Rather they are based on what has happened in the past, what is happening today and the logical extension of this technology into the future. The text is supported by 70 photos, many in color.

The author is an articulate, humorous lecturer on future living. He serves as a space consultant to both government and industry, besides addressing over 400 audiences each year.

Avery's background also includes work as a university audio-visual instructor, a radio news director, and a public relations director and consultant in the space field. He is an active member of the American Institute of Aeronautics and Astronautics, World Future Society, L-5 Society (space colony development project), and the Society of Motion Pictures and Television Engineers. He is listed in Who's Who in the West, and Who's Who in American Aviation.

Col. James B. Irwin, the eighth astronaut to walk on the moon, says of Avery's book, "The future belongs to those who prepare for it. I believe that Norman Avery's *Time Out For Tomorrow* will give you a look at the future -- the promises and the challenges."

Time Out For Tomorrow is available in book stores for $6.95, or from THAR, Box 505, Belt, Montana 59412.

Bibliography Update

by Conrad Schneiker

"The Potential of Satellite Solar Power"
P.E. Glaser
Proceedings of the IEEE, August, 1977

Yet another article by the father of Satellite Solar Power. This invited paper deals with the major facets of SSPS implementation, including the microwave system, power generation, economics, environmental impacts, legal status, space transportation requirements, orbital assembly, maintenance & manufacturing.

"System Impact Of The Dual-Expander Engine"
Robert Salkeld
Astronautics & Aeronautics, November, 1977

This letter points out that dual-expander engines, applied to horizontal-takeoff SST0 (Single Stage To Orbit) vehicles "increases payload-to-dry-weight ratio by 131%." It continues "such a potential surely merits serious attention." Indeed. This achievement is due to a modest weight savings (due to use of the dual-expander engine), giving increased liftoff velocity, allowing lower platform area (since lift increases as the square of velocity), allowing the entire vehicle to shrink.

"Space Age Review"
378 Cambridge Ave.
Palo Alto, Calif. 94306

This new magazine plans publication 12 times a year (possibly bimonthly for a short while). The 2nd issue is 12 pages long. The cost is $1/issue or $10/12 issues. It contains many short but interesting news items related to space, illustrated with black and white photographs. The articles in the second issue concern California's space day, the shuttles first free flight &excerpts from a speech by Nichelle Nichols (better known to Star Trek fans as Communications Officer Uhura).

"Space Colonies: One Step Closer"
Science News, August 13, 1977

Major point made: if shipping of the first habitat material started in 1985, then by "1991 the first colony-manufactured, solar-power satellite could be finished and producing enough electricity for a city the size of Los Angeles."

"Living in Space"
Gerard K. O'Neill
AIAA Student Journal, Summer 1977

Gives O'Neill's vision of how people will live and work in space in the near future. It could serve as a brief summary of his book "The High Frontier."

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Life Extension Magazine: Drug research, gerontology, futurism, life-extension and (if all else fails) cryonics. A very active field with some surprising successes. Bimonthly.

L-5 News: Monthly newsletter for the international L-5 Society. Summaries and original articles on studies investigating the practicallity and economic viability of various means of colonizing near-earth space with existing technology.

Earth/Space News: Published by Earth/Space Inc., engineering consultants for private space ventures. Developments and applications of techniques for private space flight. Bimonthly.

New Libertarian Weekly: Weekly newsletter of the most individualistic, pioneering movement in existence. News, philosophy, reviews, calender of events, science-fiction column. Self-liberation - not politics.

Individual Liberty: Monthly newsletter of the Society for Individual Liberty. Editorials and news briefs on the activities of freedom seeking individuals and groups of all types.

“PROJECT DAEDALUS REPORT”

(Provisional title)

Ready in April will be the “Project Daedalus Report” which will contain 24 papers which contributed to this four-year Study for a Starship Probe to Barnard’s Star.

This unique report, which runs to 160 pages, is the most ambitious and detailed Study yet undertaken for an Interstellar Starship.

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“Space Law”
George S. Robinson
Technology Review, October/November, 1977

This article is a “broad brush review of space law.” It presents a myriad of unresolved problems in this field. “The progress so far has been sketchy -- with a lot of wishful thinking.” It is interesting to note many of the legal issues revolve around philosophic questions, e.g. “should space societies be considered independent communities or colonies of earthkind?” The author answers by proposing a “Magna Carta” for space communities. This is one field that cries out for involvement by L-5ers.

“GSSPS - Taking A New Approach To The Space Solar Power State”
Leopold J. Cantafio, Vladimir A. Chobotov, Malcolm G. Wolfe
Astronautics & Aeronautics, November, 1977

In trying to improve on “brute force” SSPS design, the authors present a gravitationally stabilized SSPS (GSSPS) design. It consists of 24 pairs of 385m x 2km solar panels attached to a 72km-long, 2m-diameter circular waveguide. While having a few problems of its own, it overcomes a host of problems with “conventional” SSPS designs. Advantages: reduction of stabilization propellant needed, lower radio frequency interference, increased reliability and reduced system weight. The authors claim “the GSSPS will greatly advance the field toward an economically viable system by the turn of the century.”

“The Dual-Expander Rocket Engine -- Key To Economical Space Transportation”
Rudi Beichel
Astronautics & Aeronautics, November, 1977

The dual-expander engine allows parallel burn of two propellent combinations (using 2 combustion chambers) during the initial flight phase, followed by a sequential burn at high altitude. Due to tradeoffs in tankage weight, etc., this engine yields major performance increases. “The cost per unit weight into orbit for the space shuttle is $470/kg ($213/lb) and . . . the corresponding cost for a new vehicle design utilizing [these] new propulsion system concepts is $12/kg ($5/lb). “This engine, its operation, construction, and advantages are discussed. The author concludes “this article has concerned that word ECONOMICAL. Although only a modest step beyond the state of the art, the technical advances described in this and my previous A/A articles present the only known means of obtaining an economical space transportation system.” Doubters, note well -- the author directed the development of the V-2 power plant at Peenemunde.

“Space Applications For Terrestrial Resources”
Brian O’Leary
AAIA Student Journal, Summer 1977

“Testimony . . . before the Science and Space Subcommittee . . . [of the] United States Senate.” Builds a case for the space manufacturing approach to SPS, using asteroids towed into Earth orbit. “The total cost . . . would be many times less than the several hundred billion dollars of projected capital expansion of coal and nuclear power plants.”

Skylab: Our First Space Station
Edited by Leland F. Belew. U.S. Government Printing Office. 1977. NASA SP-400; Stock # 033-000-00670-5. $7.00. 164 pp. Hardbound.

As is becoming tradition with the NASA SP series, this book is lavishly illustrated with many color photographs. It is also an excellent popular history of the successful mission. It describes the design history of Skylab; its problems, and successes; and the scientific results from nearly six months in orbit.

Space Settlements: a Design Study (NASA SP-413), recently was published by NASA’s scientific and technical information office. It describes in vivid terms and illustrations the construction and operation of permanent settlements in space where as many as 10,000 people at some future time may work, raise families and live out their lives. The 185-page volume is based on a study sponsored by the American Society of Engineering Education and NASA, held at the Ames center and Stanford University, in which 31 engineers, scientists and students participated. The book is priced at $5.00, on sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20301 (stock number 033-000-00669-l).

William Sims Bainbridge, *The Spaceflight Revolution,* Wiley, 1976
by Vidvuds Beldavs

Bainbridge has written a highly informative book that traces the development of spaceflight as the result of a social movement. It is his thesis that spaceflight followed a pattern explained by Thomas Kuhn in the *Structure of Scientific Revolutions*. In effect, Von Braun, Oberth, Tsiolkovski, Goddard and other pioneers in the spaceflight movement acted on irrational, perhaps mystical impulses during the revolutionary stage of development of spaceflight. The post Apollo effort is no longer revolutionary science and technology but rather follows the pattern of normal science with incremental advances. With NASA spaceflight has become institutionalized and the bulk of research, development and publications deal with narrowly defined technical problems.

Initially the Space Movement was heavily influenced by science fiction. As real developments occurred in space the influence of science fiction declined and the typical SF fan became alienated and disenchanted from real events in the development of space technology. During the early stages many amateur societies sprang up in Germany, England, USSR and the U.S. advocating spaceflight and rocket technology. Within the U.S. the American Interplanetary Society soon became transformed into the American Rocket Society and later the American Institute of Aeronautics and Astronautics reflecting the voice of government and business involved in aircraft, rocketry and space.

In Germany the Spaceflight Movement effectively exploited the Nazi war machine to advance the development of spaceflight through weapons development. Apparently at no time was Von Braun seriously interested in weapons development but rather made every possible effort to gather resources and scientists to advance the cause of spaceflight. The usual topic of conversation at Peenemunde was how to get into space and not how to strike targets in England more effectively. Bainbridge presents evidence that technical incompetence, irrationality and political gamesmanship among the Nazi leadership led to the tremendous investment in the V-2 at a time of great crisis to the German nation. More than 200,000 people were involved in the V-2 program in the 1944-45 period. The program cost an estimated 2.5 billion dollars and at one time or another absorbed the efforts of one third of Germany's physical scientists and advanced engineers. The liquid fueled V-2 was a far less effective weapon than solid fueled rockets, jet planes, or other weapons that Germany could have developed.

According to Bainbridge a similar pattern occurred in the U.S. and Russia after the war with spaceflight advocates selling their respective governments on massive space programs. With the success of the moonflight and the development of Space Shuttle "the Spaceflight Movement in America has ceased to be a movement and has become institutionalized as a part of the standard government-industrial structure. The Spaceflight Movement has matured, and in succeeding, has lost its power for revolutionary growth."

Bainbridge examines the Committee for the Future as an example of how the Spaceflight Movement has continued but finds that the Committee for the Future became less and less interested in space per se and more and more interested in "pop futurology" and world planning. Bainbridge feels that groups like the Committee for the Future and SF fans do not relate to the technical realities of spaceflight as is currently being carried out by the U.S. and other governments. In effect we are in for a long period of normal science which may be followed by a Second Spacecraft Revolution. Bainbridge says,

"My overall contention is that the next 20 to 50 years will be marked by a gradual upward coasting of space-technology capabilities-a period of normal technological change. Somewhere soon after the turn of the century there is a real possibility of a Second Spaceflight Revolution."

A very interesting idea presented by Bainbridge is that there are cultural redoubts which allow for the preservation of ideas which the broader society may find useful at a later time. According to Bainbridge:

"Culture preserved in a redoubt may later emerge into the larger society. Spaceflight itself may be the best example of an idea protected and developed to some extent within science fiction and later brought to practical realization and full acceptance in the larger society. SF may contain other ideas that might not survive outside the redoubt at the present time, but may emerge strong and compelling at some future time when the conventional consciousness has changed."

Bainbridge has done an excellent job of covering the historical development of the movement. The book is weakest in its treatment of the future prospects of space flight, exploration and industrialization. He sees no sign of significant economic, military or scientific activity that would accelerate the movement into space. The considerable literature, conferences and courses on space industrialization indicate that the Space Movement has already entered the Second Space Revolution. This time the movement appears far broader and more deeply rooted than the one that took man to the Moon. Bainbridge says "there is a minor movement afoot to build floating cities in Earth orbit, an interesting if somewhat frivolous idea." This comment does not reflect a grasp of the realities and potential involved in space industrialization. Finally, we are within sight of the point where space can bring significant returns to private investors. We are on the threshold not only of a scientific and technological revolution but rather something far broader including Stine's "Third Industrial Revolution," and Leary's "Migration," Hubbard's "New World," and a restructured world order.

ABSTRACT

"Spaceflight, Colonization, and Independence: A Synthesis".
Michael A. G. Michaud
Journal of the British Interplanetary Society, March, 1977 (Part One), June, 1977 (Part Two), September, 1977 (Part Three).

An overview of the human colonization of our solar system and other star/planet systems. Part One, "Expanding the Human Biosphere," describes the limits which the Earth may impose on the human future; the escape from these limits offered by spaceflight and extraterrestrial colonization; some approaches to the colonization of our solar system (including space colonies); the eventual need to migrate beyond the solar system; the search for colonization sites near other stars; the problems of interstellar flight; and some generalizations about interstellar probes. Part Two, "Manned Interstellar Flight and the Colonization of Other Systems," discusses the problems of piloted interstellar flight; design considerations for interstellar colonizing missions; the establishment, growth, and problems of interstellar colonies ; further waves of expansion; and a new status for *Homo sapiens* in the universe. Part Three, "The Consequences of Colonization," discusses the characteristics of the early colonial generations; the influence of extraterrestrial environments; the psychology of the new frontier; social and biological changes within the colonies; the need for adaptive variety; a probable trend in the colonies toward separatism; political-military interactions; the colonies' relations with and impact on the Earth; some long-term implications of human expansion into the universe; contact with other intelligences; and a possible role for Galactic Humanity if we are the galaxy's only intelligent species.

The following papers are included in **Space Manufacturing Facilities, II,** *the collection of the proceedings of the May 1977 Princeton Conference on Space Manufacturing Facilities. Reviews by Conrad Schneiker.*

"Technical Innovation and Social Exploration in Economic Growth and Energy Development", L.P. Gerlach

Three approaches to technoeconomic operations are discussed: BIG, SMALL (is beautiful) and HIGH (frontier) as means for economical growth. "Our research enables us to explore social factors which influence resistance to, or innovation and acceptance of these approaches."

"Space Industrialization Studies-An Overview", C. Priest, R. Bradford

If one adds "from NASA's point of view", the title sums it up. Compared to other proposals for space manufacturing operations, the given time scale of activities seems stretched out and slow.

"Controlled-Environment Agriculture and Food Production Systems for Space Manufacturing Facilities", J.M. Phillips, M.R. Fontes

"In this paper, the terrestrial experience with CEA (controlled-environment agriculture) systems is reviewed, and probable adaptations of this technology to the problem of designing a food production system for O'Neill's model I space settlement are discussed."

"Physiological Parameters in Space Settlement Design", John Billingham

Reviews physiological design requirements for the O'Neill/NASA-Ames type colony designs. Discusses the need for a sensitivity analysis of costs for departing from these (conservative) requirements.

"Ecopsychiatric Aspects of a First Human Space Colony", Jay T. Shurley, Kirmsch Natani, Randal Sengel

"This paper considers the potential psychosocial problems facing the first technology satellite crew. These include anxiety, depression, hysteria, ineffectual performance, substance abuse., etc." 'The authors conclude that a full-scale simulation prior to launch and deployment is the best method to test hypotheses and to discover new and emergent behavior patterns."

"Anthropological Considerations", A. Harkins

"Among the difficulties in joining anthropological traditions to the creation of space communities are: 1) the lack of a UNIVERSAL ETHNOTHEORY amenable to CULTURAL DESIGN and POLICY FORMATION; and 2) an apparent disinterest among many anthropologists in advanced hardware technologies. Suggestions are offered for the selective employment of new trends in anthropology which could cope with 1 and 2."

"Economic Management Systems: Growth Prospects For The United States Over The Next 50 Years," W.F. Thompson, K.D. Wilson

This paper reviews a large socio-economic study of the prospects for economic growth in the United States over the next 50 years. Significant use of space solar power systems have been left out of the picture until around 2025 and are discussed very briefly. Apparently lack of funding isn't the reason as "Most forecasts conclude that about 20 percent of total capital funds generated in the nation over the next 15 to 20 years will go to the energy industry. About half (or 10 percent of the total) will be needed by electric utilities."

"Environmental Impact of Space Manufacturing", Richard R. Vondrak

Concerns "The natural environment of the earth, the moon, and cislunar space. . " As one example, there is a discussion of how lunar atmospheric interference and incomplete discharging of lunar mass driver payloads affects aiming accuracy of the lunar mass driver.

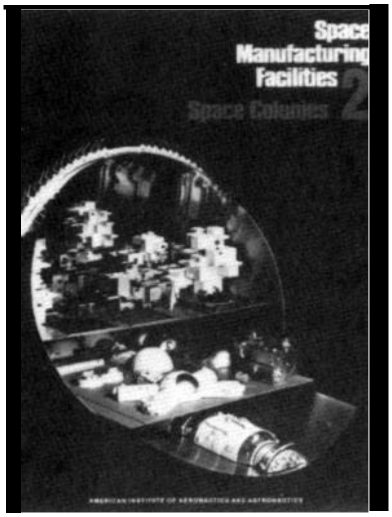
"Microwave Energy Transmission", William Brown

In addition to discussing many facets of microwave energy transmission systems, the author presents a plan for a series of progressively larger tests of such systems.

Just published --
The second volume on Space Manufacturing

SPACE MANUFACTURING FACILITIES, II
(Space Colonies)

The Proceedings of the May 1977 Princeton/AIAA Conference
on Space Manufacturing Facilities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Huntsville Conference to Feature Space Capitalist

Friday afternoon, Jan. 27, Christian O. Basler will present a paper at the Huntsville Explorer Anniversary Conference entitled "Introduction to the Staging Company Approach to Space Industrialization." A staging company is a closed-end management investment company that converts to an operating company after its research and development have brought space industrialization to the point of full commitment. As an investment company it would accumulate capital and invest in the securities of companies likely to profit from space industrialization and would spend the income from its investment portfolio on research and development, to be contracted out, for the most part, to these same companies. The object of the research and development would ultimately be firm bids for the systems being developed. Until it has accumulated enough capital, through a series of public offerings and appreciation of its portfolio investments, to proceed with full-scale space industrialization, the investment company would spend only the income from its portfolio on research and development.

After reviewing the basic concept of a staging company as first presented at the Industrialization of Space conference in San Francisco, Basler will present several aspects of staging company structure and operation not discussed in the original paper, including integration of tax shelter joint venture investment during the R & D/investment co. phase, contractual relationships between the staging company and contractors (aerospace companies?) and legal problems and solutions.

Basler will give a second paper Saturday afternoon entitled "The Economics of a Staging Company." It will include a year by year analysis of the interaction of possible R & D profiles, total costs, potential earnings, and other economic factors, focused on return on investment for initial purchasers of stock in the staging company and joint venture investors. A step-by-step description of how stock in a staging company can be sold in a series of public offerings and how other forms of financing can be utilized will also be given.

For more information on the conference, contact Prof. Donald E. Tarter, Dept. of Sociology, University of Alabama in Huntsville, Huntsville, AL 35807.

1978 Goddard Memorial Symposium

March 8, 9, 10 Washington Hilton Hotel, Washington, DC

Sponsored by the American Astronautical Society, American Institute of Aeronautics and Astronautics, Forum for the Advancement of Students in Science and Technology, National Space Institute, Institute of Electrical and Electronics Engineers, (Washington section) and the L-5 Society.

The theme of the 1978 Goddard Memorial Symposium is "Space shuttle and Spacelab utilization: what is the near-term and long-term potential benefit?" Topics covered will include student experiments, solar power satellites, space factories, space medicine, the search for extraterrestrial life, space law, science fiction, moon and L-5 bases, the Japanese, Indian, USSR, Chinese, and Canadian space programs as well as the nitty gritty details on the U.S. space shuttle and European Space Agency Spacelab.

Social activities are offered to give relief to those whose heads begin to reel from information overload. Wednesday, March 8 at 7:30 p.m. a tour of the Naval Observatory is offered. Thursday at 7:30 p.m. there will be a "Washington After Dark" tour ($11.00); and Friday noon conference attendees have the choice of the AAS/DGLR Luncheon ($12.00) or the 21st Annual Goddard Memorial Banquet ($40.00). Conference survivors who can drag themselves out of bed and get ready by 10:00 a.m. Saturday may take a tour of the National Air and Space Museum.

If you wish to attend, you must register by Feb. 26. Please use the registration form below (another registration form with more details on the conference will be mailed shortly via third class bulk mail to U.S. L-5 members, but if it fails to arrive in time you can use the form below). Hotel reservations should be made directly with the Washington Hilton Hotel by Feb. 14. Look in your local phone book for the toll-free Hilton number if you live in the U.S.; otherwise write to them at 1917 Conn. Ave. & Columbia Rd. NW, Washington, DC 20009.

Registration Form:
1978 Goddard Memorial Symposium

Enclosed is (check one):

- $25.00 non-member
- $20.00 member *(if you are an L-5 regular member, please check this item)*
- $5.00 student

Please mail to:
American Astronautical Society
Goddard Memorial Symposium
c/oMartin Marietta Aerospace
Baltimore Division
103 Chesapeake Park Plaza
Baltimore, MD 21220

Please make check payable to the American Astronautical Society.

Name ______________________________

Address ______________________________
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City State Zip

Inside the L-5 Society

L-5 is alive and well at Virginia Polytechnic Institute and State University - better known as Virginia Tech - where interest in the prospect of space settlement is steadily expanding.

Initiative toward a chapter of L-5 Society began in the spring, becoming a reality this October. Membership stands now at about 47, the goal being "as many as possible" in the words of economics major Kimber Smith who was elected to the chapter's presidency in November.

"We want to help increase public consciousness of space settlements," Smith explains. "We want to make a contribution to the educational effort. L-5 needs to reach a lot of people, and a lot of people need to reach L-5. Popular participation is the only way to go, and it starts with our local chapters.

"Virginia Tech is a 20,000 member community," Smith adds, "and every one of them is a potential member of our chapter, as we see it."

L-5 vice president at Tech is David Jones, a 5th year architecture student. Secretary is Cindy Hartman (public administration), and Lemar Roberts (biology and psychology) is treasurer.

Faculty advisor to the chapter is political scientist Jack Salmon (also a member of the L-5 Society's board of directors).

While serving as a forum for discussion and a center for the distribution of materials, Tech is taking a look at several chapter project possibilities. One member (Dave Jones) is busily fashioning a model (inside and out) of a large habitat. At last report, Jones was making mountains.

November's meeting focused on the evolution of habitat architectural design.

"We believe in cooperation," Smith notes, "so we hope to be working with the College of William and Mary L-5 on some joint projects. The people in Williamsburg have some interesting ideas about public education and political lobbying, both of which are much needed nowadays."

If you have any ideas or suggestions about projects we could consider this academic year, please send them to us.

Virginia Tech L-5 Society
c/o Kimber Smith
4016 W. Pritchard, VPI & SU
Blacksburg, Virginia 24061

The concept of space settlement has firmly taken root on the campus of America's second oldest institution of higher learning, and the historic community surrounding it.

Beginning in September (at registration itself) with an appeal to "make space settlement an assumption of the whole university," a chapter of the L-5 Society has already become conspicuous at the College of William and Mary, Williamsburg, Virginia.

Over 100 students and faculty members from 17 different schools and departments became involved in chapter activities in 1977, and many more were reached by a series of preliminary educational and media efforts aimed at the general public -- including a major news-feature in the Richmond Times-Dispatch, reporting on "a major worldwide movement."

"Everything we've done so far," says Bill Bryant, an organizer of the chapter, "is just a prelude to the work we plan to do in '78. A great citizens movement is forming, obviously, and we do intend to be very actively supportive of it. We feel that the time has come for doing -- for taking this thing to the people."

The chapter's schedule through May includes:

-- Four general meetings, plus a "floating" six-week discussion (focusing on technology, philosophy, education, social science, business and international relations).

-- Anticipated special programs featuring Gerry O'Neill of Princeton and Barbara Marx Hubbard of Washington, to be broadly co-sponsored.

-- Involvement with Sun Day.

-- Sponsorship of a Citizens Petition for the Future (to be shared soon with all L-5 chapters), starting on the campuses.

-- Preparation of a tabloid newspaper, videotape programs and a comprehensive study guide (designed for extensive classroom use).

-- Sponsorship of a special fine arts competition and showing ("Visions of Humanity's Tomorrow").

-- Presentations to other groups, both on campus and in the community (ranging from Richmond to Norfolk).

The chapter is making a liberal use of flyers, broadsides and posters, combined with regular objective reports to all local news media, to promote its own activities and the greater cause.

"It's definitely a people's cause," states Clint Wolf, the chapter's executive director. "That's why we're trying to put together a program that will reach a lot of people, with responsible information."

In addition to Bryant and Wolf, the chapter's directors are Kathy Hickey, Tim Hall, Leslie Siegmund, Karen Pitts, Jeff Strang, Libby Patten, Jeff Parker and Glen Gross.

Seven of the chapter's members participated in the special Congressional seminar in October.

Communications with the chapter should be addressed to:

Clint Wolf
Executive Director
Williamsburg L-5
P.O. Box 718
Williamsburg, Virginia 23185

Space Colonies Topic of Columbia Colloquium

Jan. 23 Colombia University's Teacher's College in New York City is sponsoring a colloquium at which L-5 Director Romualdas Sviedrys will speak on the topic of psychology of space colonies research. The public is invited to the colloquium. Although at the time of the writing of this article the time and room had not been determined, this information can be obtained from Dorothy Thorne, 212/678-3247.

The above sticker represents one of my current personal efforts to spread awareness of the space option. Shunning a timid or ambiguous message, I've combined a number of specific concepts in the hope of grabbing the attention of the average disinterested person. Judging by the reaction so far I think I am succeeding. The unusual combination of ideas generate a lot of comment and discussion. Many people are clearly dislodged from their familiar mundane orientation to issues concerning energy, resources and the environment.

Since my purpose was to reach as many people as possible I had ordered a large print run to keep the price of the sticker within a reasonable range (I hope! to break even on my expenses). It is printed in three colors (blue, green and black over white) on glossy stock 3½" x 16½" and varnished. I am making the stickers available to anyone interested, especially to organizations with established distribution arrangements.

Here are the prices:

1 -	$1.00	(1st class envelope; sticker folded once)
1-9 -	1.00 ea. +75¢	(1st class box)
10 -	9.00	(1st class box)
50 -	29.00/30.00	(3rd/1st class box)
100 -	52.00/54.00	(3rd/1st class box)

-Larger quantities are available at reduced unit costs. L-5 chapters please note resale possibilities! (Or: Send one order and distribute the stickers to members at a lower price.) Send orders to Jon Alexander, Box 216, Point Pleasant, PA 18950.

Please note that we have formed an L-5 chapter at the University of Maryland. The headquarters for now will be located at my house, which is a short walk from campus. The forms required by the university have been registered and filed. The name of the chapter is “Maryland Alliance for Space Colonization.” We have an executive committee of five now set up, including two undergraduates, one graduate student in biochemistry, one graduate student who also works for the state government and was Student Government Association president for the University of Maryland Baltimore Campus when he was an undergraduate, and myself. (Back in 1973, I set up the Harvard Committee for a Space Economy, when I was a grad student there, and we had Mark Hopkins and Siegler as members; however, when I quit as General Secretary, and turned it over to them, because of thesis and job demands, it didn’t last much longer.)

For further information, please contact Paul J. Werbos, 8411 48th Ave., Berwyn, MD 20740.

Any Society members near Midland, Texas who would like to start a local chapter should contact:

Brad Wright
3515 Gulf
Midland, Texas 79703
Phone: 915-694-0867

An Omaha, Nebraska L-5 Chapter has been formed. Interested people can contact Jay S. Moynihan, 3328 California St. Apt. 5, Omaha, NB 68131.

Canadians interested in an L-5 Chapter which will translate the L-5 News into French for further distribution are encouraged to contact Andre Fontaine - Gagnon, Ph.D., coordinator, Quebec Chapter, 1185 Ave. Brown #3, Quebec, QC G1S 3A1.

Notes from the Editor

L-5’s stable of anonymous authors put in a virtuoso performance last issue with *German Space Capitalists Under Attack* and *NASA Virtues Under Carter.* Those of you of the literary critic persuasion may enjoy sleuthing through back issues in search of articles with similar styles which include bylines. That’s all the clues we can give you - we promised not to tell!

We appreciate it when you send in items. Newspaper clippings, conference proceedings, press releases, hot tips and even rumors are the raw material from which L-5 News stories evolve.

Are you an undiscovered Great Author? Would you like to be discovered? Consider T.A. Heppenheimer. He first appeared in print in the L-5 News, and as a result of this exposure was able to catch the eye of a publisher. His first book, Colonies In Space, was snapped up by several book of the month clubs and is coming out in paperback shortly. So, even though the L-5 News pays rotten (writers usually donate their articles), if you’re really good, publication in the L-5 News could be that big break you’ve been waiting for.

What do we look for in an article? It should be accurate; packed with details, facts and, if appropriate, quotes; accurate; relevant to the goals of the L-5 Society; accurate; entertaining; and accurate.

We’re serious about that “be accurate” business. We check facts, everything from what state Senator Mosstop represents to the surface gravity of the Moon. At the first factual error we hit, the manuscript hits the wastebasket. We have discovered that an article rarely has just one error; it’s either completely accurate, or else the author is out of his or her depth and flounders in errors and misconceptions the whole way through. *Know your topic.*

Details, facts, and, when appropriate, quotes are the lifeblood of an article. Tell us who, what, where, when, why and how. Without them it’s simply an opinion piece. (We enjoy your opinions. But they belong in the Letters to the Editor section, and shouldn’t run over 400 or 500 words. The probability of having your opinion printed is inversely proportional to its length. Come up with a pithy one liner and we’ll love you forever!) If you can supply photographs or illustrations, excellent. We realize they can be expensive to make; let us know what they cost, and if we use them, we’ll send you a check.

Be relevant! We don’t care if reading the Book of Oskwash will enlighten the souls of L-5ers; the connection is too tenuous. Interviews are great only if they are with well-known personalities or major space researchers, and only if they are discussing things relevant to the human habitation of space. You may think Joe Blow in Arkansas has fascinating thoughts about space colonies, but we can’t justify spending $400 on typesetting and printing so that Society members can hear about them.

Be entertaining-or, if that’s not your style, at least be undull. The lead sentence is the most important. Examples of good leads from the last L-5 News are “Nobody seems to trust poor Lutz Kayser,” “There is apparently no substance to the rumor that Christian O. Basler is the emissary of an advanced and beneficient spacefaring species. . ,” “Keep slugging and pushing.” If you can’t come up with a real “grabber” for the lead, the next best thing is something plain, but to the point. Examples (again from the last L-5 News) are, “One of the best, and certainly least expensive, generally available sources of information for the lobbyist is . . . ” “Our topic, near Earth resources, is something new.” Whatever you do, get to the heart of the subject quickly. To paraphrase the Southern preacher’s dictum, “If you can’t hit oil in the first paragraph, quit boring.” Resist the temptation to indulge in complex figures of speech, flowery adjectives and involved jokes. For the L-5 News, less is more. Remember the professional writer who complained, “Gee, if I’d known I had more time, I would have written less.” Happy writing!

-Carolyn Henson

Beat Those Proposal - Writing Blues

A report has been released that may be of interest to L-5 Society members who prepare proposals for government contract support. The report is *The Evaluator Preference Survey* by Bob Dycus. The report presents the results of an attitude and evaluative judgement study of 33 experienced government proposal evaluators.

The unique feature of this report is that it presents empirical data on the reaction of proposal evaluators to submitted proposals. How to effectively write proposals is a highly subjective area with considerable differences of opinion among writers. Most writers rely on intuition which is developed on the basis of past successes and failures. This study is one of the first steps in measuring the effects of proposal writing, and making it a less obscure art.

The 114 page report is endorsed by the American Association of Small Research Companies. It contains the evaluator’s scorings on 139 questionnaire items, and presents recommendations for improving proposals. Although Department of Defense evaluators are used in the study about seventy percent of the questionnaire items measure the human response to proposal material, and may also be applicable to non-DOD proposal evaluators.

Letters

"Recruit Lao Tzu"

I believe that we can recruit Lao Tzu for the cause. In your November issue, a quote ascribed to him was placed among some others critical of space colonization. The quote was: "As for those who would take the whole world to tinker with as they see fit, I observe that they never succeed." He has correctly observed that the world is too complicated to deal with. Any attempts to tinker with it are more likely to cause harm than good. Such an insight leads to the conclusion that a simpler place for man's experimentation is required. This place is space. Any social or ecological error made on one space habitat is correctable at finite cost. Such errors made on the one and only earth can be fatal. So, as I see it, space colonization should be warmly embraced by all extreme environmentalists.

I believe that you should move Lao Tzu from the column of those who say no to the column of those who say yes. Since he is dead, he can't protest anyway.

George Fredericks
Colorado Springs, CO

"Star Kings"

I came across the following clipping in my papers from the period I was living in Hawaii. It was in the *Honolulu Advertiser,* part of a regular column done by a hereditary Prince from one of the most prominent old Hawaiian families, then doing time in Folsom on a bum check rap. The chant came from the old religion of the old Polynesian stock on the Islands, from the priestly chants of the Order of the God Lono:

> We have looked upon the shining depths of Earth in the dark night.
> We have set our feet upon her breast, and she has embraced us as her own.
> Yet we are strangers to this Earth, and alien to this sun,
> For our home lies athwart the barriers of time,
> And in the long flood of night,
> And far beyond the calling stars
> And our lords are the star-kings.

Our jugged Prince told his readers they could make of it whatever they would, but he himself was willing to take the next bus to Alpha Centauri, if they were willing to take a check.

It may interest some readers; after all, it might be nice if Lono's pals had a bus stop next time. Incidently, the Prince is out now.

David Murphy
Carbondale, Il.

L-5's Achilles Heel?

The Satellite Solar Power System can provide "clean" energy to any point on earth, end the energy crisis, raise the standard of living for all people on this planet, and pave the way for colonies in space. It will cost only a fraction of what the U.S. utilities would have to spend between now and the year 2000, and is based on technology we now have or expect to have in the '80s.

ERDA is currently working on the deep drilling technology that will allow us to tap the enormous heat reserves a few miles below our feet. Deep well geothermal plants which extract heat from water pumped into these deep wells can provide "clean" energy anywhere on earth, end the energy crisis, raise the standard of living, cost a fraction of what would have been spent on more conventional plants, and will be based on technology we now have or expect to have in the 1980s. This system will not pave the way for colonies, however, because it will not require many billions of dollars "up front" for lunar mass drivers, "construction shacks". and the like. Sinceeach plant will beessentially modular and will not require massive investment for transportation, mining, etc. it could offer a more attractive investment opportunity for Washington or Wall Street than the SSPS.

If something like deep well geothermal or OTEC (which uses the temperature differences in the oceans) becomes available as a possible solution to the world's problems, and can be shown to cost the same as or less than the SSPS. how are we going to sell theconcept of powersats to Congress or private industry? And if we cannot sell the SSPS, how do we justify the billions of dollars necessary to build space colonies? Congress and private industry are notorious for their short-sighted outlook and willingness to follow the path of least resistance.

Is anyone out there looking into other economically-justifiable (i.e., profitable) space projects besides the SSPS which can generate the billions of dollars needed to get space colonization "off the ground"? I do not want to see the whole concept of space settlements go down the tube because we hitched our wagon to the wrong horse. Any comments from the members of the L-5 Society?

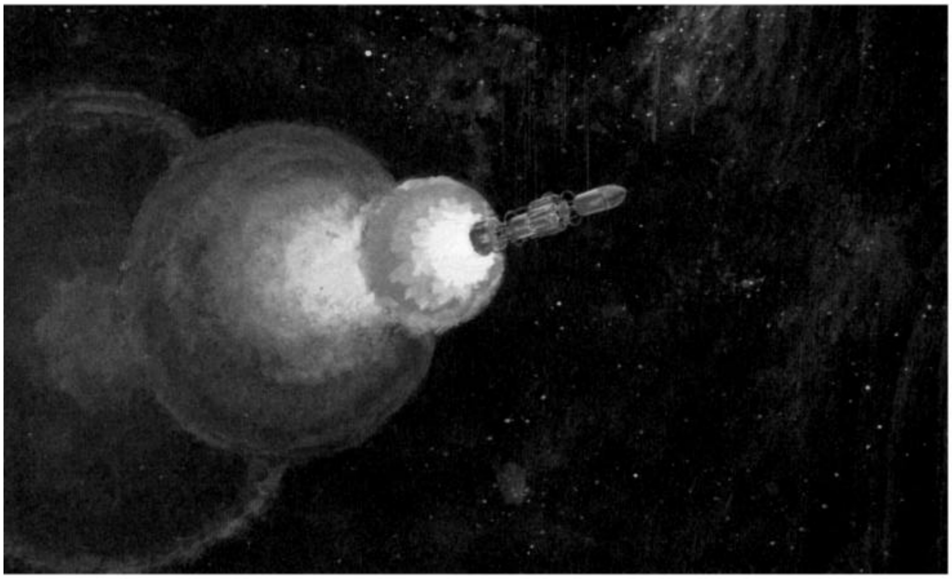
Robert G. Lovell, Jr.
Shawnee, Kansas

Stogies in Space

I do not think that the matter of smoking in space colonies is very simple.

For one thing, the increasing size of non-smoking areas in airplanes, restaurants, and the like indicates one trend. Secondly, so far as I know none of the astronauts were smokers and we therefore have no notion as to what the physiological effects may be on a person undergoing daily changes from O-G to 1-G. Thirdly, it is obvious that those in the construction areas of O-G will not be able to smoke. Fourthly, I can not imagine that any tobacco firm will pay $160 per kilogram freight charge nor do I think that many colonies will have enough agricultural space that they will devote some to the raising of tobacco.

Kirk H. Stone
Research Professor
University of Georgia



Bus to Alpha Centauri: Pictured here is the Orion nuclear pulse jet interstellar ark, a 400,000 ton vehicle which uses 300,000 small fusion bombs for propulsion. Attaining 1/30 the speed of light, it can make the trip to Alpha Centauri in 130 years. (Photo courtesy Hughes Research Laboratories.)

Comment on Goldwater

Barry Goldwater clearly represents an extreme political viewpoint. I believe that his election, at least without that of a "counterbalancing" democrat, could hurt the L-5 Society's cause.

Paul Patton
Green Bay, WI

Convey my best wishes to Senator Goldwater. On the issue of space industrialization I find myself, a "liberal democrat," in total agreement. If the subject can unify the two of us, it certainly can unify the world! Darth Proxmire, take note!

Gary D. Miloglav
Piedmont, CA

Maybe Barry Goldwater should think of running for U.S. President on the L-5 ticket with Dr. O'Neill as his VP.

Roy S. Furst
Baldwin, NY

Hasn't that been tried before? -- MB

Lobbying Notes

The article in the October issue of the L-5 News entitled "So You Want to Lobby" was extremely informative. However, the article did not list two very important People which a person could write. They are:

1) President Carter, of course.
and
2) Acting Director James T. McIntyre, Jr.
Executive Office of the President
Office of Management and Budget
Washington, D.C. 20503

Respectfully,

G. M. Wannamaker
FPO NY

L-5 Graphics

For your information, I received the November 77 issue of L-5 News today. Your graphic organization is getting much better. (On the subject of space colonies it is important to have a professional look to the graphic layout in order to make a favorable impression on intelligent people.) Thanks for putting the mailing label on the back cover this time. (I preferred envelope mailing.)

-Jon Alexandr
Point Pleasant, PA

Corrosion Questions

I wish to raise the question of the corrosion of space colony structural materials. Corrosion on the external side which is in contact with vacuum may be negligible, though radiation damage, erosion by micro-meteorites and evaporation of heated surfaces may take place. However, on the internal side, the structural walls will be in contact with air and/or soil at levels of humidity, acidity and oxidizing potentials similar to those under terrestrial conditions. The rate of corrosion of metals under these conditions is not necessarily negligible. In turn, corrosion will lead to weakening of the wall materials, which may become serious in view of the strain exerted on the habitat structure. Corrosion damage may thus result in lifetimes for these habitats which may be more limited than we intuitively tend to assume. In this case amortization of the habitats will have to be taken into account in the economic evaluation of space colonization. In any event, the corrosion problem will have to be taken into account in the design of structural materials.

Michael Mautner. Ph.D.
The Rockefeller University
New York, N.Y.

Social Models Needed

The aspect of the human colonization of Space that really intrigues me is the unprecedented psychosocial environment in which we will be living. Historically, settlers of new realms have encountered problems and effected solutions unknown in their old environment. Clearly -- and especially -- human Space colonies will not be simple cultural transplants from Earth.

As John Sotos observed in his letter (August, 77), "Space habitation cannot afford to be trial and error." The internal (psychological, spiritual) and external (Physical, social) tools for manifesting clear, sharp and exceedingly satisfying human interactions -- suitable for the conditions of Space living -- exist today. Yet, to my knowledge, no teams of people employing these techniques in daily living, with the goal of adapting them to the Space environment, currently exist. Let's get busy now establishing these social models, so when the technology materializes out there we'll have living teams worthy of occupying them! These exemplary communities, fundamental to human life in Space, would be another benefit to the Earth from this great venture.

Ron Lichtwardt
Honolulu, HI

"Too Much Idealism"

On the question of the military uses of outer space I would like to say that too much idealism has been shown by the comments in the Newsletter. Space activities should be kept peaceful, but not at all costs. Not at the cost of liberty and individual freedom. As George Orwell wrote in "*Looking Back on the Spanish War*", "For the truth is very simple. To survive you often have to fight, and to fight you have to dirty yourself. War is evil, and is often the lesser evil."

Lawrence Boyle
Chicago, IL

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Please enroll me as a member of L-5 Society ($20 per year regular, $10 per year for students). A check or money order is enclosed. (Membership includes *L-5 News*, $3 to members; the balance -- $17 or $7 -- is a tax-deductible donation.)

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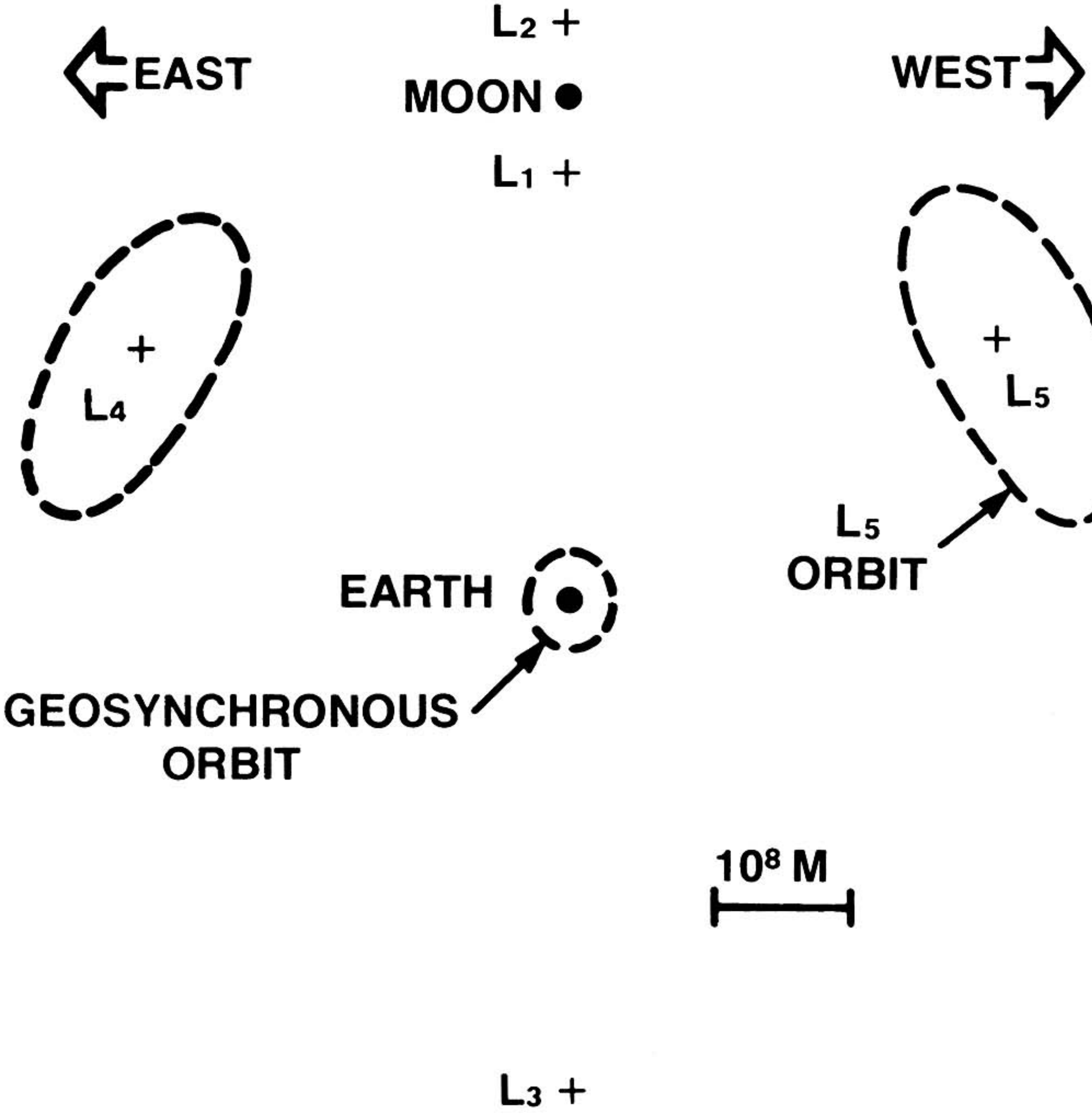

L5 NEWS

FEBRUARY 1978

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In this issue:

1 **Congress Pushes SPS** Is the solar power satellite concept on a “going out of business curve”? Not if Congress can help it. Carolyn Henson reports.

2 **“Congress Has to Set Priorities”** A report on the Future Space Program hearings.

4 **A Crassly Expedient Act** Space colony researcher T. A. Heppenheimer decries the Administration’s attempt to mothball the Enterprise.

5 **OTRAG: Bold Pioneer Faces Hostile World** Conrad Schneiker gives a detailed report on OTRAG’s trials and tribulations.

7 **Soyuz-26 Mission, Spacelab Progress** Phil Parker reports.

8 **Space Industrialization: Whence Cometh Confusion** Researcher Gerry Driggers gives a capsule explanation of what’s happening in the field.

9 **SPS: Near Future Energy Source**? Find out why SPS is attracting serious interest as the answer to the energy crisis.

10 **Space Colonies** A book review by Conrad Schneiker of another of the flock of books that will tell you everything you wanted to know about living in space.

11 **Inside the L-5 Society**

13 **Life Extension Conference**

14 **The Best of the Industrialization of Space Conference**

16 **What’s Available from the L-5 Society?**

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Cover: A proposed heavy lift launch vehicle, a space freighter which could lower launch costs to $15/lb within this century. (Artwork courtesy Boeing.)

Congress Pushes SPS

by Carolyn Henson

Complaining that NASA and DOE's solar power satellite (SPS) research is on a "going out of business curve", twelve members of the House of Representatives have introduced a bill which would fund SPS research in fiscal year '79 with $25 million.

The bill, HR10601, entitled the Solar Power Satellite Research, Development and Demonstration Act, was introduced by Rep. Ronnie G. Flippo (D-AL). Cosponsors are Representatives Olin Teague (D-TX), Don Fuqua (D-FL), Walter Flowers (D-AL), Mike McCormack (D-WA), Larry Winn (R-KS), Bob Gammage (D-TX), Louis Frey (R-FL), Jim Lloyd (D-CA), James Blanchard (D-MI) and Dale Milford (D-TX). The bill calls for a new SPS development plan to be drawn up by Sept. 30. The plan would supercede the SPS Concept Development and Evaluation Program plan which has planned expenditures of only $19.5 million from 1977 through 1980. The current plan allows no further hardware development, concentrating on evaluation of research already done in the field. SPS researchers have been concerned over the plan's "go-no go" decision date in 1980, complaining that, without further hardware development and research, the only possible decision would be that SPS cannot be demonstrated to be economically feasible. Researchers have also objected to the Administration's refusal to include some of the more promising SPS designs in the study. The space manufacturing facilities approach is one which has been excluded. Observers accuse DOE of choosing "straw. man" SPS designs for further evaluation, making it easier to "prove" that they are economically unfeasible.

As things now stand, the SPS project appears slated for extinction by 1980. Will Congress change the direction of Carter's energy policy with HR 10601?

If you want to be a player in the drama unfolding in Congress this year, you can get wired into the hot line by joining L-5's "So You Want to Lobby" information service.

If you wish to receive up-to-date news via first class mail and, in emergencies, via phone, please send in the following information:

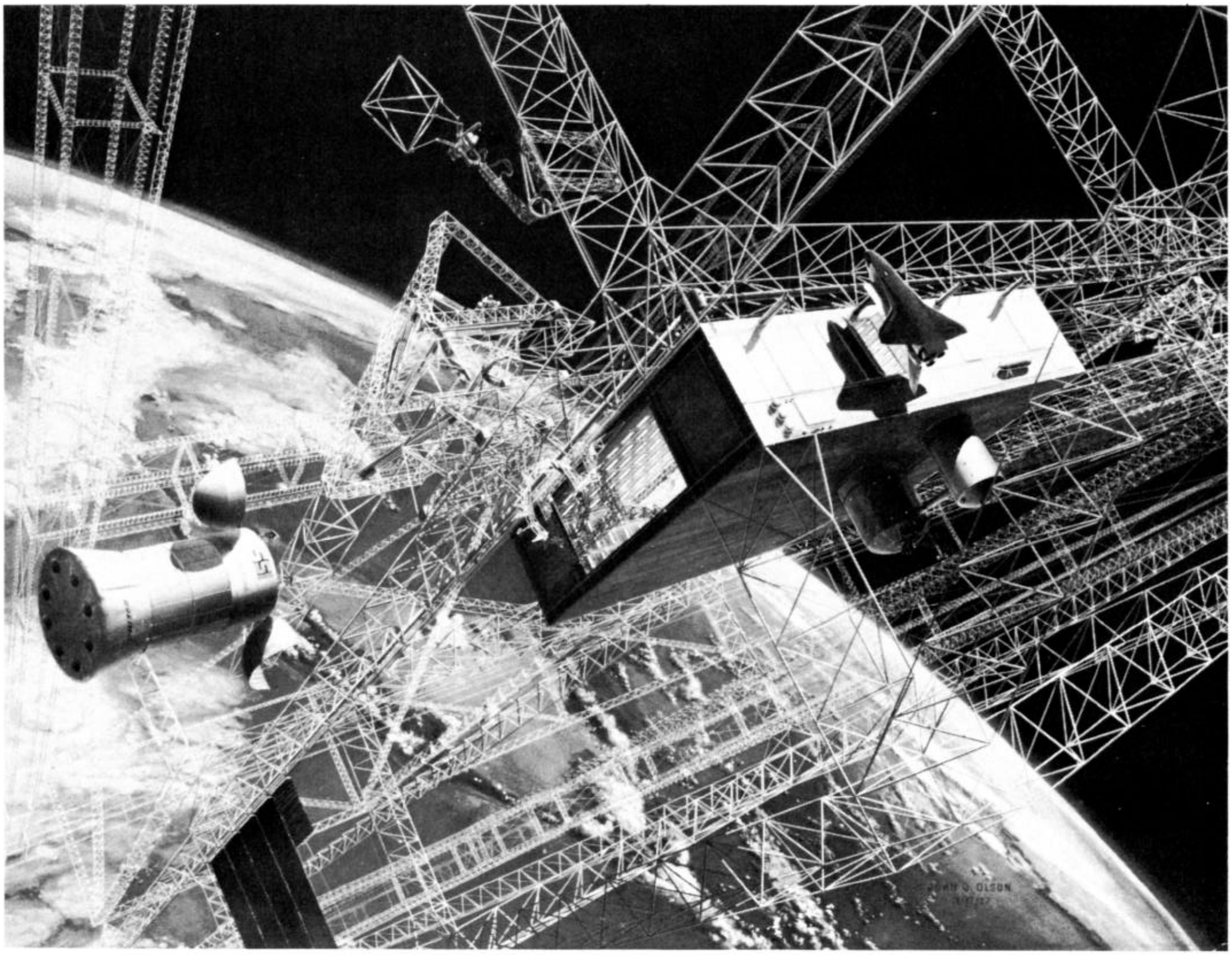
Your address, and, if you are willing to accept a collect phone call from the Society, your phone number.

A brief essay on your background and how you plan to take political action.

Whether you can drop everything and go to Washington to attend hearings and meet with your Congresspeople.

Whether you will need a place to stay when in Washington (area members please notify us if you can put up out of town visitors).

Whether the Society has permission to pass your name and address along to responsible space oriented lobby groups.



A solar power satellite in construction in low Earth orbit. A shuttle is docking at a "hangar" in which space construction workers operate; at the left is a freighter rocket which brings up parts. *(Illustration courtesy Boeing.)*

"Congress Has to Set Priorities"

by Carolyn Henson

A sizeable contingent of L-5 members showed up in Washington for the Future Space Program hearings Jan. 24-26. The hearing room was jammed; at times people were standing in the back and the aisles. Many of the L-5 people met with their Representatives and staffers while in Washington delivering well thought out written statements and encouraging them to attend the hearings.

Interest in them was high. Normally only members of the Space Science and Applications Subcommittee (which sponsored the hearings) attend their hearings. But this time members of several other Science and Technology subcommittees attended as well as some Representatives who were not even on the Science and Technology Committee. The Subcommittee chairman, Don Fuqua, allowed all the Representatives in attendance to question the witnesses. Staffers for dozens of Representatives were in the audience.

Four of the thirteen witnesses testified in favor of space settlements. They were G. Harry Stine, author of the *Third Industrial Revolution;* Charles Sheffield, Vice President, Earth Satellite Corporation: Barbara Marx Hubbard, author of *The Hunger of Eve;* Gerard K. O'Neill, Princeton physics professor, and Lawrence Adams, President, Martin Marietta Aerospace. The Representatives were quite cordial and openly helpful to these witnesses.

Dr. Phillip Handler, National Academy of Sciences; Frank Press, Carter's Science advisor; and Robert Frosch, Administrator of NASA got up on the witness stand to explain why space industries, settlements and solar power satellites should have the low priority given them by the Carter Administration. The Representatives were surprisingly hostile to them. Barbara Mikulski (D-MD) told Handler, "Congress has to set priorities, not you," and demanded that he submit the criteria on which he based his evaluation of the space program. Louis Frey (R-FL) complained that "I don't see the sense of urgency, committment -- we've been talking long enough."

Under questioning Handler, Press and Frosch all admitted that solar power satellites (SPS) were technically feasible. Press, when told by James Scheuer (D-NY) that "when you do nothing you make policy" and "I don't get a feeling of zeal," replied that "there's no question we've got to get there; the problem is to explore possibilities." Scheuer responded that "you learn by doing" and proposed that a prototype SPS be built immediately. Press countered by saying that "we have to get $16 million behind us before we can make a prudent decision." Ronnie Flippo (D-AL) objected that it would take three years at current SPS funding rates to make a decision.

Barbara Mikulski telling Phillip Handler "Congress has to set priorities, not you." *(Photo courtesy Charles Divine.)*

Larry Winn (R-KS) pretty well summed up the Representatives' frustrations with the Carter SPS policy, saying "I don't mean to sound rude -- but we've been listening to you (Press and Frosch) for one hour and we're not hearing a damn thing that's new . . . if this is what we've got for energy, we'd better sell the Saudis our F-15's."

Four days after the administration's testimony, an alternative SPS bill was introduced by Ronnie Flippo (D-AL) and cosponsored by 11 other disgruntled Science and Technology Committee members, including the chairman of the Fossil and Nuclear Energy Research, Development and Demonstration Subcommittee, Walter Flowers (D-AL); the chairman of the Transportation, Aviation and Weather Subcommittee, Dale Milford (D-TX); the chairman of the Advanced Energy Technologies and Energy Conservation, Development and Demonstration Subcommittee, Mike McCormack (D-WA); the chairman of the Space Sciences and Applications Subcommittee, Don Fuqua (D-FL); and the chairman of the Science and Technology Committee, Olin Teague (D-TX). For details on this bill, HR 10601, "Solar Power Satellite Research, Development and Demonstration Act" see the related article, "Congress Pushes SPS" in this issue of the L-S News.

NASA Administrator Robert Frosch faces Congress.

Gerard O'Neill testifying at the Future Space Program hearings.

A Crassly Expedient Act

From the center - T.A. Heppenheimer

The proposed 1979 Federal budget, the first to fully reflect the views of the Carter Administration, must certainly be a shock to all who advocate an expanded space program. President Carter has struck at the very heart of the mainstay of any such expanded efforts -- the Space Shuttle. This comes through his recommendation to delete funding for the fifth Shuttle Orbiter, reducing the Shuttle fleet to four in number, instead of the planned five.

The proposed five-orbiter fleet reflects anticipated traffic, as developed through careful NASA and contractor studies, and represents a fleet size calculated to permit most effective use of this new space transportation system. Thus this Carter Administration decision must be taken as earnest of an intention to reduce our already inadequate space efforts by another 20% -- if not by more.

Such an action would hardly be out of keeping with the viewpoint of an Administration which has given high responsibility to Walter Mondale. During his Senate days, Mondale stood high among the inveterate foes of the space program. In 1970, with Space Shuttle funding set at only $12 million in the budget, Mondale sought to strangle the program at its birth by moving to delete this item. In 1971, 1972, and 1973, Mondale again and again sought to delete Shuttle funding, abandoning his efforts only when it became obvious that the program enjoyed overwhelming support.

Fortunately, there is ample opportunity to move to restore funding for the fifth Orbiter. The budget must be passed by Congress, and friends of the Shuttle can introduce amendments. But to aid in this, it will be important to muster public support.

Such support can only be enhanced by the fact that the Orbiter craft to be scrapped is, indeed, the famous *Enterprise*. That craft received that name through the efforts of a hundred thousand Star Trek fans. Such support, if mobilized and focused, will prove more than enough to send a warning to Carter: Hands off our space program!

Such organizations as FASST, the AIAA, and the L-S Society can play a vital role in energizing and directing this support. There's a lot to do. Let's get to work. Let's show this Administration that our space program is not for cutting.

Dr. Thomas A. Heppenheimer was born in 1947. In 1971 he co-founded FASST (Forum for Advancement of Students in Science and Technology), and served as its Vice-President/Technical. In 1974 he was named to a temporary appointment to the faculty of California Institute of Technology. In 1976 he was named Alexander von Humboldt Research Fellow, in the Max Planck Institut fiir Kernphysik, Heidelberg, West Germany.

His principal research areas include planetary science, aerospace engineering, and celestial mechanics. His 1976 discovery of achromatic trajectories has since led to major advances in the understanding of the problem of transport of lunar resources, for use in space industrialization. More recently, he has given new solutions in dynamics which Point the way to a complete understanding of the early history of the asteroids.

He is the author of *Colonies in Space* (Stackpole, 1977). widely regarded as the definitive work on space colonization. It has been selected by the Book-of-the-Month Club, and by five other book clubs.

He is listed in Who's Who in Aviation and in Who's Who in the West.

OTRAG: BOLD PIONEER FACES HOSTILE WORLD

by Conrad Schneiker

INTRODUCTION

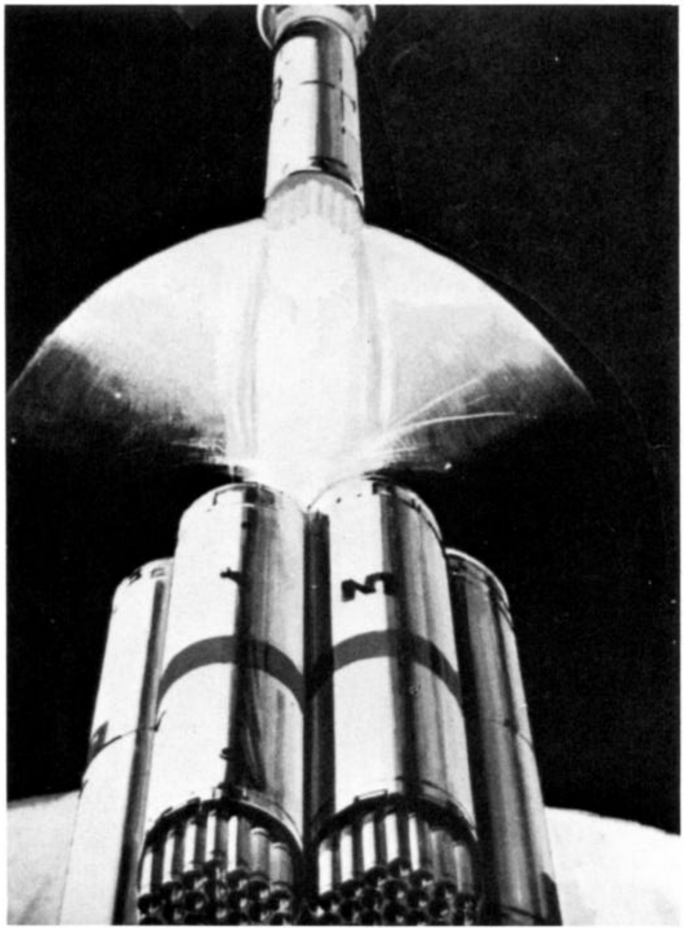
In past issues of the L-5 News, articles of interest to our readers have been reviewed individually. The large volume of articles on OTRAG has made such a treatment a formidable task. The large degree of overlapping reports would make the task very monotonous as well. For these reasons this article was written to summarize some recent articles on OTRAG. They are listed in the bibliography for interested readers.

OTRAG -- THE COMPANY

OTRAG's goal is to slash the high cost of rocket launch vehicles to half the cost of existing or planned launch vehicles. OTRAG (Orbital Transport und Raketer Aktiengesellschaft) is a West German firm, headed by 38 year old Dr. Lutz T. Kayser. He has made 31 inventions in rocket technology to date [7]. Chairman of the Board of Directors, Kurt Debus, was director of the NASA Kennedy Space Flight Center. He directed the world's first tests of large rockets at Peenemuende [2]. He worked with the late Werner Von Braun. Kurt Debus describes the OTRAG rocket as "brilliantly simple [12]."

OTRAG's starting capital was only $425,000. Money has been invested by "a score of West Germany's big earners who can write off their investment through tax deductions." Now it is financed entirely by some 600 private investors. It has contracted with Zaire for a launch area. The contract is through the year 2000, with payments deferred until 1980, at which time Zaire will receive 5% of the sales revenues.

OTRAG has spent about $30 million on the development of its launcher, using a small team of about 40 engineers. It has already flown its first test vehicle. On the other hand, "the German-French project -- ARIANE -- has not yet yielded any results despite the huge amount of money ($400 million) put into its development [8]." This last amount is what OTRAG figures it will spend by the time it starts regular operations in 1980-1981. It also figures that its prices will undercut ARIANE's.



Artist's conception of the OTRAG multistage rocket, planned for launch in late 1979. *(Photo courtesy Theo Pirard.)*

OTRAG -- THE ROCKET

The "low-cost rocket" is based on clustering many standard tank and engine modules. The number of modules used varies with the weight of the payload to be launched [15]. As many mass-produced, off-the-shelf components are being used as possible. Every attempt is being made to simplify the overall system. For instance, compressed air is used to move fuel instead of turbopumps. The inexpensive and plentiful fuels, kerosene and nitric acid, replace the expensive and hard to obtain UDMH fuel. Thrust chambers are ablatively cooled, a technique usually reserved for solid fuel rockets. Automobile windshield wiper motors actuate fuel valves (which are used by the chemical industry).

The largest OTRAG rocket configuration is sized to place about 1/3 as much payload weight in low earth orbit as the Shuttle. However the diameter of its payload bay is 8m compared to 5m for the Shuttle. In addition, ". . . payloads for the Shuttle will be very expensive because they must be man rated, which will not be the case for the OTRAG launcher. . . . Shuttle payloads will have to be qualified to much higher noise-fatigue levels because they will be so much closer to the engines . . . during launch."

The first test flight reached an altitude of about 20km. Another test flight is scheduled for early 1979 and the first orbital insertion is planned for later that year.

OTRAG: AFRICA'S CAPE CANAVERAL

"Until now Africa's participation in the application of space technology for the economic and social development of the continent had been limited to the use of INTELSAT communication satellites. This has considerably improved Africa's communication with the outside world but not the links between one African country and another [6].” With the arrival of OTRAG, this may soon change. For “the role of satellites is gradually shifting from international to national systems. The trend is clearly towards separate domestic satellite systems which make it possible for a developing country to determine its use for its domestic instead of depending on the INTELSAT system which is entirely outside the control of governments using it.”

OTRAG is prepared to launch spy satellites for African nations (or anyone else). As a result “no major military move, such as a concentration of troops, activities on military bases, airfields and even roads can escape the watchful eye of the satellite cameras. The recent detection of the South African nuclear testing ground in the Kalahari Desert is a good example.” Lutz Kayser takes the view that “until recently much of this spectacular achievement was cloaked in unnecessary military secrecy . . . [7].”

Compare this with an earlier dialogue in the U.S. “ ‘As we go into the future,’ says Director, Defense Research and Engineering, Malcolm Currie, ‘we may have to establish resolution limits on various kinds of sensors used in unclassified programs [16].’ ” For instance, “DOD and NASA have ‘intensely’ discussed NASA’s development of the thematic mapper which will provide resolution of 30m (compared to the 80m now available on Landsat with the multispectral scanner).” Once OTRAG’s rockets are operational, such considerations will be passe. For OTRAG can fly satellites with “wide angle, high precision cameras that can register an object on the ground the size of an automobile.” This is (very roughly) a factor of ten improvement over a resolution of 30m. And with modern equipment, one can do much better.

Apparently the DOD has company in its worries: “Others, however, have linked the publicity given to the [Pravda] press report with Soviet efforts to amend the Space Treaty limiting the launching of reconnaissance satellites to the Soviet Union and the United States [7].” OTRAG considers launching spy satellites a positive activity as “. . . consequently, any contemplated armed aggression can be discovered in time to allow the Security Council of the United Nations to intervene and prevent the conflict.” These launches may be big business. “. . . 80 per cent of the satellites in orbit, that is almost 2000, were launched exclusively by the two superpowers -- the United States and the Soviet Union -- for military reconnaissance purposes [6].” How many more satellites will be launched when (say) 10, 20 or 30 more countries get into the act?

OTRAG -- THE CONTROVERSY

“. . . OTRAG’s launching site in Zaire has given rise to international controversy with cold war flavour [6].” First we consider the accusation leveled at OTRAG. This controversy followed the announcement of OTRAG’s leasing agreement with Zaire by the Paris-based Afrique-Asie [11]. “. . . the editor of Afrique-Asie -- Simon Malley -- had obtained details of an agreement signed between OTRAG and Mobutu in Kinshasa on March 26, 1976. Central figure in the revelation is Nathaniel M’Bumba, shadowy commander of the abortive Shaba ‘invasion’ earlier this year [1977] whose ‘guerilla informants’ discovered the ‘secret documents’ detailing the deal.” The alleged “cost to the Germans is a monumental $29.95 million a year. . .” In addition, “the socialist states regard the leased area as a ‘military base.’ ” The Soviet paper Pravda followed up by repeatedly damning OTRAG’s operations militaristic [4, 7, 10]. Soviet President Leonid I. Brezhnev “condemned the West for establishing ‘military strongholds’ in Africa . . . [12].” At this point a column appeared in U.S. newspapers noting the “. . . most curious aspect of the entire fascinating matter is the thunderous silence of the whole American media [10].” Perhaps taking a hint, Penthouse magazine made public an article scheduled for publication in March 1978. It charges “West Germany has taken over a Colorado-sized chunk of Zaire where it is secretly producing and testing cruise and intermediate range ballistic missiles with U.S. approval . . . [14].” Furthermore “prototypes of four or five cruise missiles, designed to carry nuclear warheads, have already flown over the 100,000 square mile area.” The article quotes the lease rate at $50 million per year. As usual, the CIA is involved.

Now, the defense. According to OTRAG spokesman Frank Wukasch, “what we originally started as a scientific project has suddenly, for unknown reasons been blown up into a politico-strategic fairy tale [11].” Why such tight security? “Such a costly project is closely guarded as it would anywhere else in the world. But our work is in no way a state secret. The launching of the first rocket was covered by a German TV team and has been shown in Germany.” In fact, “when he blasted off his first rocket last May 17, he hired a public relations firm to publicize the successful launch [12].” What about huge payments for the lease? “A farce [11].” What about the hostile Soviet reaction? A news article notes: “It is hard to believe that West Germany is really and truly installing a base for nuclear missiles in the heart of southern Africa. The Soviet Union knows exactly how to play on Western fears of a revived German militarism, and such a maneuver would give them a superb propaganda weapon [lo].” Why lease such a large territory? “. . . to ensure that burnt-out parts of our [OTRAG’s] launchers shall not cause any damage. . . . Otrag is liable for any damages to life, the health of the people in the area and their property. . . “OTRAG will not agree to any cooperation with the Republic of South Africa as long as its government pursues a policy that is condemned both by the Organization of African Unity and the United Nations.” What about the launching of nuclear warheads? “We shall provide the launching services only after we are satisfied that such a satellite is for peaceful purposes only as they are defined by the [UN] Space Treaty.” What about Brezhnev’s claims? “He ought to be better informed about the project. We frequently see Soviet MIG-23 reconnaisance jets over our testing grounds [12].”

The Penthouse article deserves special mention. The actual area of the lease is 38,000 square miles, not 100,000 as claimed in the article. This is about 100,000 square kilometers; perhaps the units were switched? As for the “Colorado-sized chunk of Zaire,” the author may be interested to learn that Colorado is roughly 270% larger than the area in question. The author claims the article was based on “private discussions with highly reliable sources who have access to most of the relevant knowledge . . . [17].” Hard facts & actual names of these sources are lacking however. West Germany’s reaction: “Pure nonsense [13].” OTRAG’s reaction: “This report is complete nonsense.” The U.S. State Department’s reaction: it has no evidence that cruise missiles are being tested in Zaire. The sleazy reporting in this pretentious screed prompts one to dismiss its claims as prima facie absurd.

CONCLUSION

What to make of all this? We are witnessing a shift away from de facto government monopolies toward free enterprise in space operations. We are witnessing the end of the US-USSR monopoly on spy satellites. We are witnessing an end to the idea that experts in the world’s space agencies were always right when “they said it couldn’t be done.” We are witnessing an end to the idea that space operations will unfold according to the imposed plans of a few national agencies while they retain the upper hand. And looking back on all this, we see that it’s just as well.

Many Third World nations look quite favorably at the prospect of achieving a measure of independence from the superpowers in their space activities [6,9]. New possibilities are opening up for these nations. They will be able to make their own choices instead of being limited to such activities as the world's "Big Brothers" deem acceptable. This doesn't sit well with those in positions of power and control. Hence the reactions of uneasiness, suspiciousness, andoutright hostility directed at OTRAG. But no matter. OTRAG's perseverance, ingenuity and boldness have carried it this far -- success now appears within its grasp.

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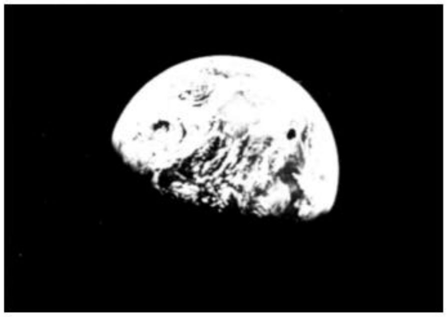


SOYUZ-26 MISSION

by Phill Parker

On the 10th of December, 1977, the USSR launched the Soyuz-26 spacecraft using a standard 'Soyuz' launcher to undertake rendezvous and docking with the orbiting Salyut-6 space station on the 11th December 1977. The crew for this mission is flight commander Yuri Romanenko and flight engineer Georgi Grechko. It is interesting to note that Grechko was also flight engineer for the earlier Soyuz-17 mission which docked with Salyut-4 space station in 1975. The latest launch comes only two months after the failure of Soyuz-25 to carry out docking with Salyut-6 in October 1977. It appears that the USSR used the crew of Soyuz-25 to take photographs of the damaged docking port of Salyut-6, after their failure to link-up with it, and to undertake ground simulation and dummy crew operations on a ground simulator before launching Soyuz-26 on a 'rescue mission'. The USSR announced that Grechko has been responsible " . . . in testing and designing new space technology." According to Vladimir Shatalov the Soyuz-26 crew will be responsible for the testing and checking of the damaged docking port in the transfer compartment of Salyut-6. The Soyuz-26 spacecraft docked with a second docking port on Salyut-6 on the instrument section.

Besides testing the damaged docking port, other events planned for the Soyuz-26 crew are the study of physical processes of outer space, the exploration of earth's resources, medical and biological investigations and carrying out technical experiments. It is expected that the crew will attempt to exceed the long-duration record of the USA's Skylab-4 crew, which was 84 days in space. The Soviet Union has been more forthcoming with this mission than many others and showed television pictures of the launch, rendezvous and docking (via a remote camera onboard Salyut-6), interior transfer of crew from Soyuz to Salyut and, at a later date, the crew at work and explaining various units within Salyut. From these television pictures, it appears that the space station is more 'electronically sophisticated' than its forebears and there seems to be more computerized equipment. The live pictures were, also, in color, which also seems to be step forward and would rank the Salyut-6 space station on par with Skylab. Another interesting point about Salyut-6 is that water condensates are recycled, removing the need for the large water tanks which Skylab used. Another point is that the USSR is using its large 'Mission Control Center' at Yevpatoria for this flight and is equivalent to Houston in its apparent sophistication with electronic flight plans and computerized displays.

SPACELAB PROGRESS

by Phill Parker

Europe's first manned spacecraft, Spacelab, being developed by the European Space Agency (ESA) is progressing according to schedule with various models having been developed for testing and development. Various hardware items for the 'Engineering Model' are undergoing assembly at the prime contractors site at Bremen in West Germany. The next critical stage is the so-called Critical Design Review (CDR) in February 1978 at which the compatibility of subsystem interfaces and of actual design with the design requirements will be established over 40 major firms in 10 European countries are helping in the construction of Spacelab.

The first launch of the European Spacelab has been delayed, however, until December 1980 due to a delay in launching the Tracking and Data Relay Satellites by NASA for use with the Space Transportation System. NASA has now decided to launch the TDRSs by the shuttle, rather than by expendable launcher. Also leading towards this first flight was a Crew Station Review was recently undertaken by staff from ESA, NASA and the prime contractor, ERNO but resulted in few suggestions for hardware changes -- a good sign! The software aspects, however, were highlighted and remedial action is taking place. A Spacelab simulation, using the NASA Galileo aircraft, was undertaken in the ASSESS-II mission between 16-25 May 1977. The simulation demonstrated that a multiple payload experiment can be operated successfully by a small number of payload specialists.

Space Industrialization : Whence Cometh Confusion

by Gerry Driggers

What's in a name? A great deal actually, since names represent mental images and evoke emotional attitudes. The actions (or inactions) spurred by the receiver's perceptions are the effects; the names and labels are the cause.

There are presently many concepts and images associated with the terminology when reference is made to "space industrialization." With some the vision conjured up is one of large space colonies housing thousands of people building or making something. Others see big structures being built in space for whatever purpose from the bay of the Shuttle. Another fairly common image involves space stations and construction bases in Earth orbit. Many people see relatively specific activities such as space processing of materials, product manufacture or solar power satellites as the essence of space industrialization.

Whence cometh confusion? A multiplicity of images and perceptions fostered by one thing: a lack of commonly accepted, coherent definitions.

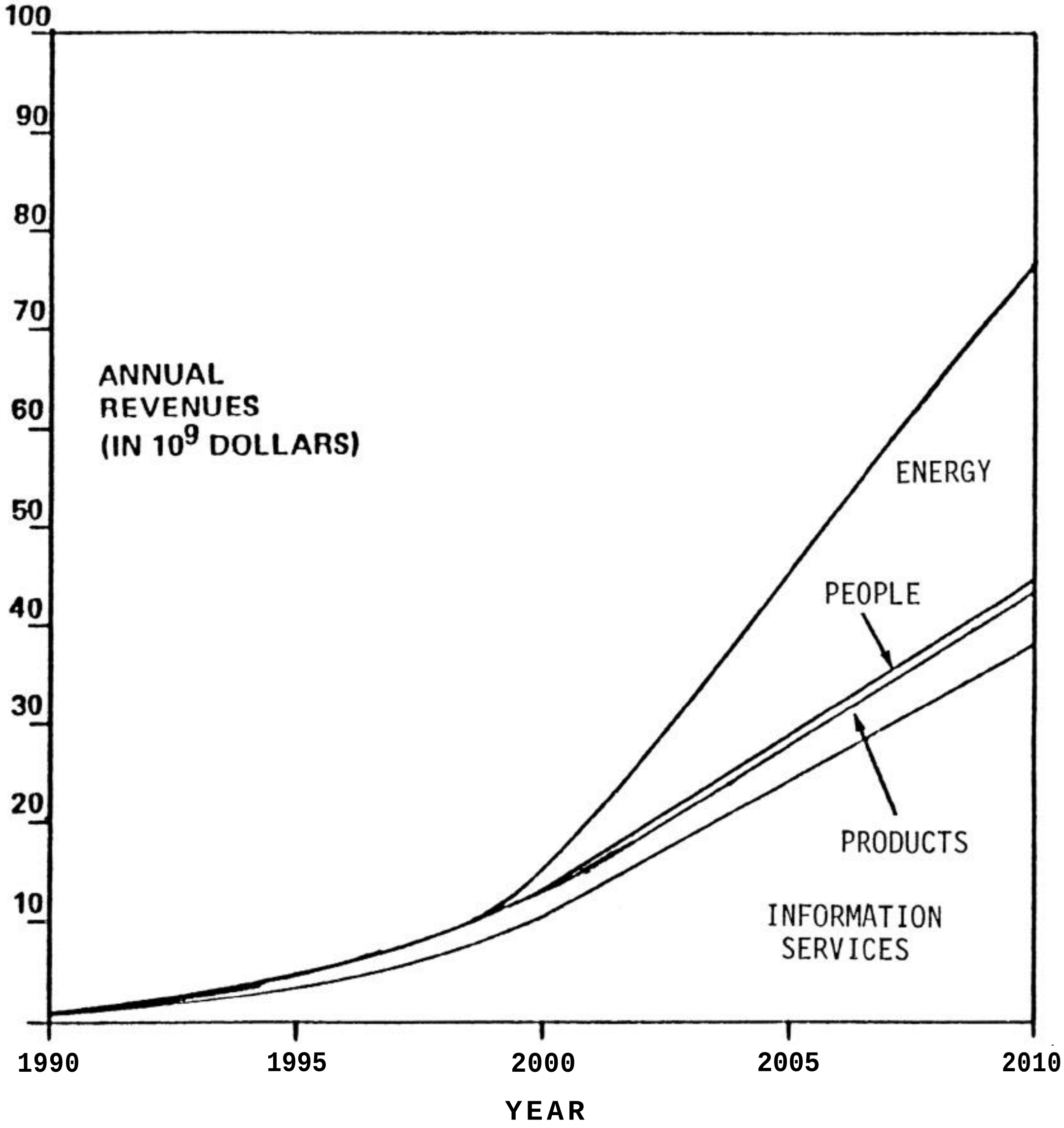
Two study teams (funded by NASA/MSFC), one at Rockwell International and one managed by Science Applications, Incorporated have been involved during the past eighteen months in defining space industrialization, delineating the characteristics of its elements and postulating its possible future developments and the related benefits. Final reports from these studies will be published in March, 1978. One result of these studies has been a set of definitions. Simply stated, space industrialization is industry and government working for profit and pragmatic benefit utilizing space. Understanding the total content of this statement requires some elaboration.

First, space industrialization (SI) is not a "program." It is at the least a collection of programs, some private, some government and involving many nations. It may also be said that space industrialization is not an activity but a collection of activities. SI today involves communications, navigation, remote sensing and launch services at about one billion dollars in annual revenue. About 146 nations are involved in SI related activities and six of these have launcher status. In the near future (early to mid-eighties) will come products from space followed in the nineties by power initiatives such as the solar power satellite. People in space as an industry then becomes a reality around the year 2000.

Thus SI activities can be generally categorized over the next thirty years under four headings: Information Services, Products, Energy and People in Space.

The size of these various activities can be characterized several ways but the most convenient has been a projection of potential annual dollar revenues. An estimate of gross revenues based on market surveys made during the SI Study are shown in the accompanying figure. These revenues are based on a relatively conservative future projection of U.S. market potential and penetration rate. A few industry and government initiatives in earlier time frames could easily accelerate the scale by five years.

The point of the figure is made regardless of the time scale, however. The composition, relative timing and relative scale of impacts on Earth for space industrialization are illustrated.



A Projection of Future U.S. Space Industrialization Activities Based on Conservative Market Penetration Rates

SPS: Near Future Energy Source?

Introduction:

We live in an age in which we are rapidly diminishing our supply of Earth's resources. Global population and standard of living is increasing and as a result we are experiencing rapidly increasing rates of consumption of available fossil and nuclear fuel stores. As a consequence, we may expect existing global energy sources to last only to the following approximate dates: oil, 1995 to 2005; coal, 2030 to 2080; and uranium (without breeder reactors), 2020 to 2050.

As our available energy resources are consumed, secondary factors emerge. First, as remaining quantities become more difficult to obtain, the cost will increase. Locating and drilling for oil, for example, is a very expensive and time consuming process. Much of this cost is absorbed by the consumer. The second factor is that the consumption of available energy sources results in additional pollutants to the biosphere. The CO_2 removed from the atmosphere over thousands of years by plants, which formed coal, is now being returned. Third, since energy sources tend to be geographically concentrated, with most coal reserves in the United States and the Middle East possessing most of the oil resources, a potential for international tension may be created as reserves dwindle. Fourth, nuclear fission involves byproduct materials that could be dangerous in the wrong hands.

The Alternative:

Recently the potential of solar energy to meet future needs has been re-examined. The sun radiates vast quantities of energy that are far in excess of needs in the forseeable future. The principle way in which solar power could be put to use on Earth is by turning it directly into electricity through the use of solar cell arrays or "farms." Solar plants on Earth, however, suffer from the fact that the sun's energy reaches Earth in a very dilute form due to the diffuse nature of solar radiation, clouds, haze, etc. The most severe setback to the use of Earth-based solar systems, of course, is nightfall.

The Answer:

One way to harness solar energy effectively would be to move the solar "farms" off the surface of the Earth and place them in orbit away from the Earth's active environment and erosive forces. A space system would receive 6 to 15 times more energy per year than the same sized system located on Earth. In addition, a power plant located in space can receive nearly direct, unfiltered sunlight almost without interruption. These benefits were what prompted the concept of the Solar Power Satellite (SPS).

The design concept of the SPS consists of a satellite maintained in a geosynchronous orbit around the Earth. This means that the satellite would remain in a fixed position in relation to a point on the surface of the Earth. On the satellite, two symmetrically arranged solar collectors convert solar energy directly into electricity by the photovoltaic (solar cell) process. The electricity is fed to microwave generators built into a transmitting antenna located between the two solar collectors. The antenna directs the microwave beam to a receiving antenna on Earth where the microwave energy is efficiently and safely converted back to electricity. Power could be delivered to most geographic locations with the receiving antenna placed either on land or on platforms over water.

Benefits:

The foremost benefit produced by the SPS is that it utilizes a virtually inexhaustible source of energy. There is no possibility of running out of energy from the sun in the foreseeable future. As mentioned previously, the SPS would receive from 6 to 15 times more energy than the same system on Earth, and would receive it virtually continuously.

The SPS system appears truly environmentally safe. It would produce no pollutants to the air or water and would not rely in any way on the dwindling energy resources. The materials required for construction and implementation of the SPS are abundant and the SPS would pay for itself in only two years in terms of the energy required to make it operational. This includes the raw materials, manufacturing processes, component assembly, space transportation and ground support facilities.

Open land under the receiving antenna could still be put to productive use. All incoming microwaves would be either absorbed by the antenna or reflected back into space, but 80% of the sunlight can still pass through. Thus, the land beneath the antenna would not be "dead space" since it could be put to agricultural or other uses.

Safety Features:

The SPS does not possess the potential for dangerous side-effects as with nuclear power plants. It is important to note that because of the inherent nature of the microwave transmitting system, it is impossible to direct the beam to any point on Earth other than the properly configured receiving antenna. This is due to the fact that the microwave beam is only attracted to the receiving antenna, and in fact, only remains a beam if pointed at the antenna. Otherwise, the microwaves transmit out from the satellite in a fine "spray" in all directions and are as harmless as a radio signal.

Because a microwave beam is non-ionizing, it does not affect biological materials in the way that ultraviolet, X-ray or nuclear radiation does. Its major effect on living tissue is heating. Microwaves do not produce ionization or chemical changes because the energy level is much too low. Precautions will be taken at the microwave receiving station to insure that the levels of microwave intensities to which employees are exposed are well below government standards for safety.

Since heating is the only effect microwaves have on biological tissue there would be no cumulative effect after repeated exposures. It works on the same principle as home microwave ovens except on an extremely small scale. If a sandwich is put into the oven to be warmed, it can be removed and allowed to cool and then returned to the oven for re-heating. This can be repeated again and again with complete safety because there are no harmful rays which are collected or stored.

There would be no danger to aircraft passengers flying through the beam because they would be shielded by the metal body of the aircraft. The time required for an airplane to fly through a microwave beam would not be long enough to harm even an unshielded person.

Conclusion:

Solar power satellites may be the answer to our energy shortage in the near future. Research is being carefully conducted to insure that this system would be totally safe from every standpoint. There is good reason to believe that the SPS will be as safe and beneficial as the communications satellites in use at this moment. These are the satellites which provide the public with live football programming, less expensive world-wide telephone service, educational programs and so many other improvements in communications.

It is important, of course, to examine all energy alternatives carefully and weigh the benefits and drawbacks of each. The solar power satellite is one alternative, and hopefully, the answer.

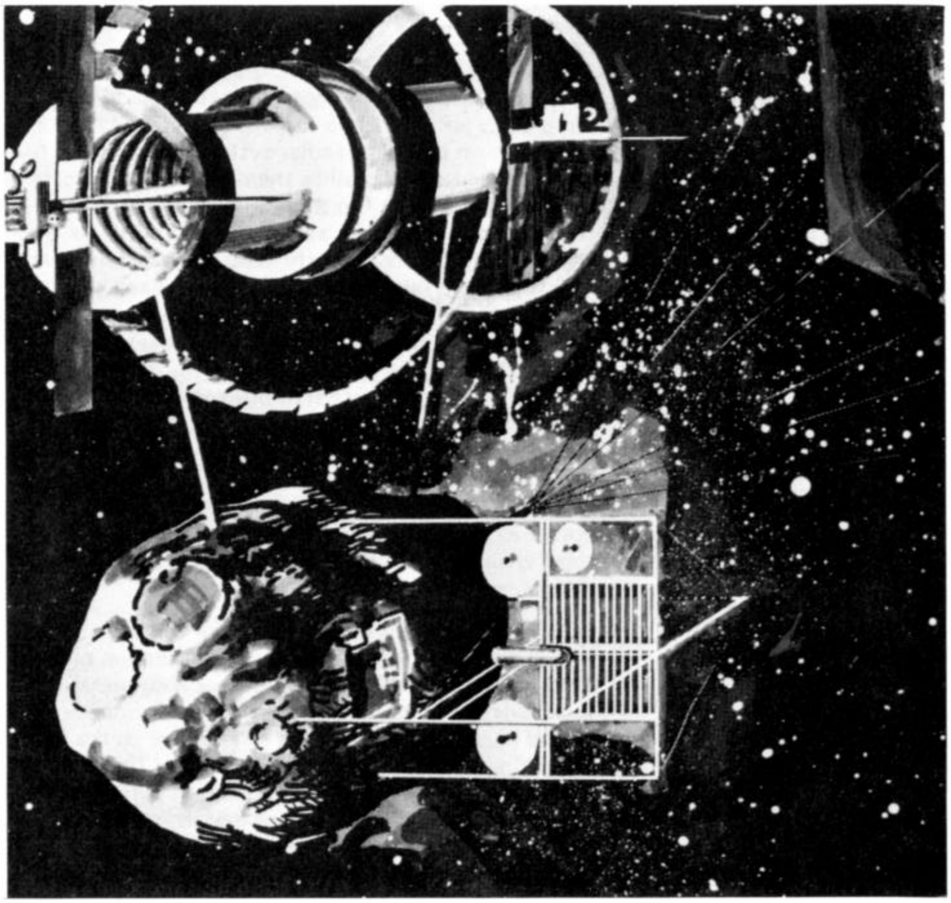
Space Colonies

Edited by Stewart Brand
Review *by Conrad Schneiker*

The book consists mainly of reprints from past issues of The CoEvolution Quarterly. This includes the pro & con debates, several interviews each with physicist Gerard O'Neill and astronaut Rusty Schweickart (including the famous "There Ain't No Graceful Way [in zero-g]" interview), many WHOLE EARTH CATALOG style book and periodical reviews, many pictures, drawings, diagrams, and much more.

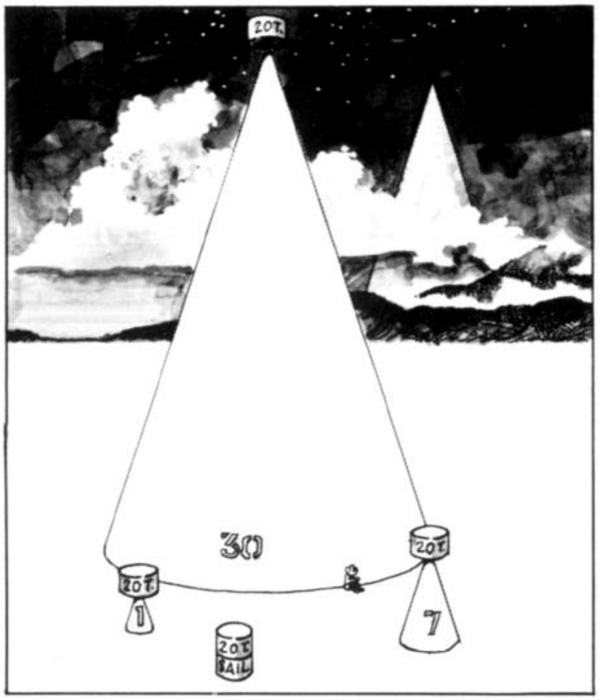
There is some new material, most notably two articles by Eric Drexler: "The Space Colonies Idea 1969-1977" & "Solar Sailing." The first article (in spite of its title) presents several interesting scenarios for the future development of space colonization. Then follows the best answer to "BUT CAN IT BE DONE?" that I have seen yet. After disposing with technological critics, the ideological critics are attacked with a vengance -- again, with the best replies I've seen to date. This article is a model defense of space colonization, giving concise arguments that clearly expose the (often ugly) roots of the opposition's stand. The defense stands on its own merits; there's no glossing over the issues, changing the subject, or wishy-washy apologetic mumbling about extra-terresterial imperatives and the ilk here.

The second article discusses a new type of solar sail design, 40 times lighter and 40 times faster than pervious designs. This spectacular advance results from construction of these sails in space instead of on earth. An important consequence: the possibility of $.10/lb costs for transportation around the solar system (assuming a 10% real rate of interest on capital). Questions on the feasibility of such sails are listed and answered. Read the article for the interesting details.

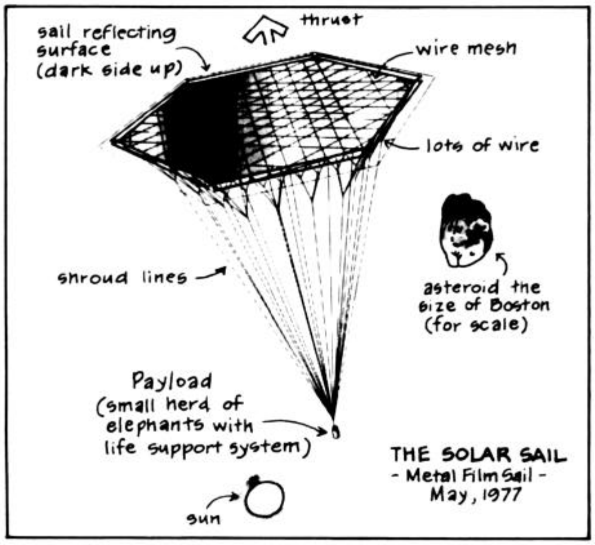


Asteroid mining facility with moored sail. Top, right: solar sail (10 km diametcr). Top, left: Bernal Sphere colony (½ km diameter). Bottom, left: asteroid (1 km diameter). Bottom, center: industrial complex. Behind asteroid: mooring tower with shroud lines extending to sail in the distance. The pit on the right side of the asteroid has supplied enough material to build this colony, the industrial complex. 50 power satellites, and many, many sails like the one shown. The solar system contains thousands of similar asteroids.

Illustrations shown here are reprinted from **Space Colonies.**



Solar sails and chemical rockets. Rocket mass increases exponentially with the velocity to be reached. In the foreground is a 20 ton payload sitting on a representation of a 20 ton solar sail. To its left is a similar payload resting on a cone (labeled "1") representing the mass of the chemical rocket needed to reach the velocity that the sail could reach after a day's acceleration. On the right, the cone labeled "7" represents the mass of a rocket to equal the velocity given by the sail in 7 days. Similarly with the cone labeled "30" (note man napping at base). In the background, behind Mt. Everest, is a 50-mile tall cone representing the mass of the rocket needed to equal the velocity with which the sail can throw 20 tons out of the solar system. An electric rocket would be considerably smaller.


sail reflecting surface (dark side up)
thrust
wire mesh
lots of wire
shroud lines
asteroid the size of Boston (for scale)
Payload (small herd of elephants with life support system)
THE SOLAR SAIL
- Metal Film Sail -
May, 1977
sun

Inside the L-5 Society

An L-S meeting was held Jan. 28 at the Huntsville, Alabama conference celebrating the 20th anniversary of the launch of the United States' first satellite, Explorer. The participants, many of whom had also attended the Future Space Programs hearings in Washington, D.C., Jan. 24-26, requested that their names and addresses be published.

Harriett Hays -- 205/776-3940
Brock Rd.
Brownsboro, AL 35741

Tim Katterman -- 919/833-1398
P.O. Box 5381
Raleigh, NC 27607

Bret Hooper -- 615/383-4680
921 Kirkwood Lane
Nashville, TN 37204

Bill Gardiner
1269 Mecaslin St. N.W.
Atlanta, GA 30337

Mike Hogue
Box 265
Corinth, MS 38834

Linda Jordan
101-A Jardane Rd.
Pensacola, FL 32507

H. David Futch
Box 554
Conyers, GA 30207

David Wood
Box 1921
Birmingham, AL 35201

Frank Love
1217 Cheister St.
Birmingham, AL 35226

Kenneth McCormick -- 215/469-6513
Birchrunville, PA 19421

Eric Laursen -- 215/662-1668
217 S. 46th St.
Philadelphia, PA 19139

Wm. Scott Rone -- 601/232-8244
Box 1280
University, MS 38677

Richard E. Yinger -- 305/968-8478
6120 Ranches Rd.
Lake Worth, FL 33464

Neil and Ursula Freer -- 914/679-8519 or 679-7137
Box 297
Rt. 2
W. Hurley, NY 12491

Robin Snelson
144 West 80th St., #3
New York, NY 10024

H. Daniel Futch -- 404/922-5699
Box 554
Conyers, GA 30207

Gary Noyes -- 904/378-4362
289-5 Corry Village
Gainesville, FL 32603

Chris Pollari
Box 37151
Georgia Tech
Atlanta, GA 30332

Chuck Domm
4113 Grenton Ave.
Baltimore, MD 21206

Guy Pignolet
P.O. Box 844
97477 St. Denis Ceder
Reunion Island, Indian Ocean

Roy S. Furst
1866 Fargo St.
Baldwin, NY 11510

James T. Anderson
736 N. Euclid Ave.
Tucson, AZ 85719

Marc Boone
1620 N. Park
Tucson, AZ 85719

Chris Basler
New York City

R.R. Basler
Menlo Park, CA

Warren Merkey
University of Florida

Alan R. Hildebrand
1419 43rd St. N.E.
Calgary, Alberta Canada, T2A3L5

Jim Norwood
1112 Irving Rd.
Birmingham, AL 32509

L-5 Ole Miss:
Micky McWilliams, Howard Taylor, Tracey Flanagen, Scott Rone, Rance Fortenberry
Box 5563
University, MS 38677

Klaus Heimburg
2507-36SW 16th Pl.
Gainesville, FL 32608

George Koopman
Huntington Beach, CA

Carolyn Henson
1134 E. Lester
Tucson, AZ 85719

A directory of all L-5 members who wish to be active locally is available upon request from the L-5 office. Be sure to specify whether you wish only a list of those in your locality, or a complete world-wide printout.

Inside the L-5 Office

As those who have worked as volunteers in the L-5 office can testify, running the Society is 90% elbow grease: stuffing envelopes, checking the mailing list to make sure address changes were made correctly, filing invoices, sorting mail, packaging orders, keeping cash receipts up to date, vacuuming the floor, changing light bulbs, etc. It's not very dramatic -- but office work is darn essential.

It's been awhile since we've given credits to our many volunteers who have toiled so hard in the office. They include Jay Vivian, Cambridge, MA; Terry Cooper, Tucson, AZ; anonymous lady, Ann Arbor, MI; Bev Isbell, Chico, CA; Ron Nickel, Odessa, TX; Roger Gregory, Ann Arbor, MI; Jim Bennett, Santa Cruz, CA; Debbie Haney, Kokomo, IN; and John and Paul Fortier of Detroit, MI.

If you would like to participate in the most unglamorous side of Society activities, we will provide room and board in exchange for 12 hours a day of office drudgery. As we have a limited amount of space available, please write in and tell us when you would like to visit and wait for someone in the office to give you the OK before packing up and coming on out.

Bryna Block -- she coordinates the mail order business and runs "Bryna's Bread" on the side.

Ron Nickle -- volunteer.

Elinore Hanes -- the L-5 bookkeeper. She keeps us honest.

Donations

In the last six months nearly one fourth of the Society's income has come from donations ranging from one dollar to $5000. Counting in the impact of volunteer labor as well, the Society has been able to provide nearly twice the dollar value of services as would be possible if we had to rely solely on membership fees. People who have donated money in the last half year include Barbara Marx Hubbard, Bill O'Boyle, Timothy Leary, Marjorie Stuart, Dr. and Mrs. Erik P. Paterson, Jerry D. Lentz, James Kempf, G.M. Wannamaker, Cole Lovett, John K. Clark, Michael Davis, Ralph C. Merkle, Scott Royce, Wm. C. Tetley, E.F. Bagley, Heidy Lukas, Richard A. Sexton, Paul Reynolds, Bruce R. Harlan, Thomas O. Paine, James Seevers, Cole Lovett, Peter Zavon, Gary Lackowski, David Gale, Jeffrey Pimick, Gerald Krauleidis, anonymous, S. Friedman, Barry Cole, Stanley Grenstein, David Spiek, Leroy Lauer, John Paul Sissa, James A. Shumaker, Malcolm Walker, and Fred Manzo.

Local Chapters

Are you still alive? We want to know which local chapters are still functioning. Write in this month and tell us what's going on and we will send you a "CARE" package of bumper stickers, lapel buttons, promotional pens, and brochures. Please -- this is important. We are updating the directory of local chapters and will only list those who Prove they are alive by writing in!

Errata

The designer of the Austin L-5 T-shirt was incorrectly identified as John Delano. The artist is Joe Visserr.

In the Dec. '77 issue the article "Do You Sincerely Want to Become Rich'?" states "Imagine a corporate animal designed to raise and send $100 billion." That should have been "spend," not "send"!

Mass Driver Help Needed

Any help in locating non-electrolytic capacitors with a rating between 10 and 500 microfarads and a voltage rating of more than 600 volts would be appreciated. They are needed for the construction of the second mass driver which is being built at Princeton this spring. It is planned to accelerate a small payload up to about 1000 g's. (That's zero to 350 miles per hour over a distance of four feet.) If you locate some of the capacitors, please contact Bill Snow, SSI, P.O. Box 82, Princeton, NJ 08540.

Space Studies Institute Off to Big Start

Prof. Gerard K. O'Neill's Space Studies Institute has received over $100,000 in donations. The fact that his support is currently coming almost entirely from individuals rather than corporations or the government is indicative of the grass roots support undergirding his space settlements research.

If you would like to join the Space Studies Institute, you can subscribe for $10 (although more is appreciated!) Your tax deductible gift will go towards supporting one year's equipment purchases and administrative work at SSI. Please sent it to:

Space Studies Institute
P.O. Box 82
Princeton, NJ 08540

Jim Loudon, a well known space and astronomy popularizer in the midwest, is available for speaking engagements anywhere, on astronomical topics such as space colonization and industrialization, the Viking missions, the history of the space program, and more. The cost is $200 plus expenses (see if your school or church won't pick up the tab). Write to James A. Loudon/1109 Geddes Ave./Ann Arbor, Michigan 48109. Jim is the author of the Viking Notes.

The Austin Chapter of the L-5 Society has been quite active at the University of Texas in the past year. We meet on the second Wednesday of each month at 7 P.M., usually at the Texas Union. Meetings include an L-5/space oriented presentation or discussion session, a news update and general business period. There is also a social gathering/discussion group which meets on the fourth Thursday of each month at 7 P.M. in the Texas Tavern on campus. Club activities over the past year have included a trip to San Marcos to hear Gerard O'Neill, a trip to the Johnson Space Center, a reception for T.A. Heppenheimer and a slide and lecture presentation by Harlan Smith (Chairman of the U. T. Astronomy Dept. and McDonald Observatory and member of the L-5 Board of Directors.)

Membership has grown to about 50 active members and some meetings have drawn over 150 Folks!

Another major program of the Chapter is a Public Outreach group which has given slide and information programs to many local public schools, civic groups and university organizations. Response has been excellent!

I encourage interested persons to write or call us and attend the meetings, if possible. Also, we can help other groups with organizational problems and provide access to information. (We have a quickly growing library.)

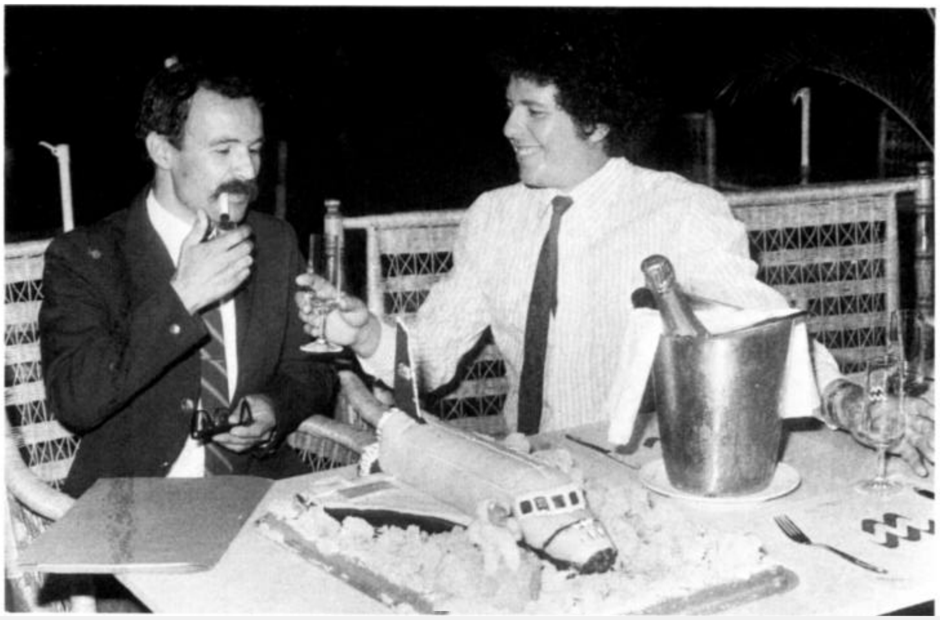
We'd like to hear from you.

Write:

The L-5 Society
University of Texas, Austin
P.O. Box 8213
Austin, TX 78712

Or call:

Debbie Byrd
c/o the U.T. Astronomy Dept.
Austin, Texas 78754



L-5 member Guy Pignolet, pictured here on the right (with Jean Francois Riviere on the left) is celebrating a "Bonne Anee Spatiale" New Year's Eve at the Meridien Hotel on Reunion Island in the Indian Ocean. That's right, they ore about to eat a cake shaped like a space shuttle and astronaut.

An exploration of the prospect of prolonging youth, vigor, and lifespan in humans

Alcor LIFE EXTENSION Conference

Los Angeles International Hyatt House
-- March 11-12, 1978

Program

On the first day of the Life Extension Conference, prominent research scientists will present a comprehensive picture of the current state of the life extension sciences. During this session, the field of biomedical gerontology -- the study of the aging process -- will receive major attention. Other fields covered will include suspended animation, resuscitation, transplantation, prosthetics, and identity reconstruction.

Some of the scientists who have agreed to participate in this session are:

Leonard Hayflick, Ph.D., Children's Hospital Center of Northern California, Oakland
Richard Cutler, Ph.D., Gerontology Research Center, National Institute on Aging, NIH, Baltimore
Paul Segall, Ph.D., Dept. of Physiology-Anatomy, Univ. of California, Berkeley
Gerard Hirsch, Ph.D., Staff Biologist, Oak Ridge National Laboratory, Oak Ridge, Tenn.
Bernard Strehler, Ph.D., Biology Dept., Univ. of Southern California, Los Angeles
Roy L. Walford, M.D., Dept. of Pathology, UCLA Medical Center, Los Angeles
Peter Gouras, M.D., National Eye Institute, NIH, Bethesda, Md.
T. Makinodan, Ph.D., Wadsworth V.A. Hospital, UCLA Medical Center, Los Angeles
Jerry Leaf, Dept. of Surgery, UCLA Medical Center, Los Angeles
Allan L. Goldstein, Ph.D., Chief of Biochemistry at the Univ. of Texas at Galveston
Robert W. Prehoda, author of *Extended Youth: The Promise of Gerontology and Suspended Animation*

On the second day of the Life Extension Conference, there will be sessions on anti-aging therapies, cryonic suspension, and the implications of life extension. Some of the individuals who have agreed to participate in these sessions are:

C.A. Everone, Foundation for Infinite Survival, Inc., Berkeley, California
Richard Huchschild, Ph.D., Univ. of California, Irvine
Benjamin Frank, M.D., author of *Nucleic Acid Therapy in Aging and Degenerative Disease*
Fred Chamberlain, Alcor Society for Life Extension, Los Angeles
Arthur Quaife, M.A., President, Trans Time, Inc.
Herb Gerjouy, Ph.D., The Futures Group, Glastonbury, Conn.
Timothy Leary, Ph.D., author, lecturer, psychologist
F.M. Esfandiary, philosopher, teacher, author of *Upwingers*
Alan Harrington, author of *The Immortalist* and the forthcoming *Paradise I*
A. Stuart Otto, Chairman, The Committee for Elimination of Death
Barbara Marx Hubbard, The Committee for the Future, Futures Network, Wash. D.C., author, *The Hunger of Eve,* lecturer
Robert Anton Wilson, co-author of *Illuminatus* and the forthcoming, *Cosmic Trigger: The Final Secret of the Illuminati,* lecturer
Saul Kent, author, *Future* Sex and the forthcoming *Life Extension Handbook,* lecturer, consultant
Keith Henson, L-5 Society

Registration is $30 at the door and $25 for those who register by mail prior to the conference. Student registration is $15.

Registration form

NAME ______________________ AFFILIATION ______________________

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I enclose registration fee of $25 for admission to the Life Extension Conference and a one year subscription to LIFE EXTENSION Magazine. Students: $15, including special offer. I further enclose $___ to cover registration fees for the following people [include names and addresses].

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The Best of the

Industrialization of Space Conference

Held Oct. 18, 19 & 20, 1977, the conference was sponsored by the American Astronautical Society, American Institute of Aeronautics and Astronautics, American Society for Quality Control, British Interplanetary Society, Institute of Electrical and Electronics Engineers, International Institute of Space Law, L-5 Society, National Space Institute, and SRI International.

The following papers have been selected by the L-5 Society as representing the best of the conference. If you can't wait for publication of the complete proceedings by the AAS, or if you are only interested in certain of the topics carried by the conference, the papers reviewed below (by Conrad Schneiker) can be purchased from the L-5 Society. The AAS will receive 50¢ per paper sold to help them continue their pioneering work.

Space Habitats

A Preliminary Investigation of Space Habitat Atmosphere
AAS 77-284
Warren Ziegler
$1.67
Reports results of author's theoretical "study of space habitat atmosphere, dynamics, hydrostatics, particulate and cloud physics."

Aesthetic Implications Of The Crystal Palace Space Habitat
AAS 77-285
Marjorie L. Stewart
$3.21
"The goal of this study is to discover the maximum aesthetic conditions possible in [the crystal palace] . . . and to formulate suggestions for enhancing the habitat from a standpoint of human liveability and aesthetic factors."

Space Manufacturing

A Baseline Of Logistic And Power Requirements For Full-scale Manufacturing Of Metallic Materials
AAS 77-237
H. L. Bloom
$2.37
Data from preliminary surveys on space processed materials are presented and "developed into a representative baseline of the logistic and power requirements of a future mature space manufacturing program." An interesting point is raised: "Requirements for disposition of wastes have been a 'sleeper' in studies of materials processing in space."

Power from Space

Freedoms And Constraints In Solar Power Satellite Design
AAS 77-200
Ray Sperber, Harley Zipursky
$2.30
A surprising number of new SPS configurations are being developed. This paper surveys some of these designs. "Aspects of geometric, structural, electrical, optical, orbital assembly and implementation systems design are discussed in terms of freedom and constraint as they affect power satellite design."

Satellite Mirror Systems For Providing Terrestrial Power: System Concept
AAS 77-240
Kenneth W. Billman, William P. Gilbreath, Stuart W. Bowen
$3.14
Half the cost of a conventional solar farm is due to storage equipment. A satellite mirror system providing continuous, slightly increased insolation is proposed. The storage system can be eliminated and the solar farm land area can be reduced in size by a factor of 5. The system "appears to be economically superior to other advanced, and even conventional, energy systems . . . "

In Orbit Manufacture Of Solar Reflector Satellites
AAS 77-241
Ronald M. Muller
$2.02
Presents design and construction scenario for gigantic orbital mirrors for use with. terrestrial solar farms. The major components of these mirror satellites are described.

Social Implications

Energy Crisis: A History Lesson
AAS 77-212
Romualdas Sviedrys
$1.60
Past energy crises are reviewed and their recurring features noted. None of the many dire, doom-filled predictions made during these crises materialized. In each case technology saves the day. It is shown that "with each energy crisis there was a jump to greater wealth."

The Military Uses of Outer Space
AAS 77-251
Leonard David
$2.37
"Space has become an extension of Earth-bound military land, air and sea warfare." We are told how this came to be and what future developments may be expected. Also discussed: how new technologies are nullifying past legal commitments (even as argument over their interpretation continues), the justifications for military activity in space, denial of space access, U.S. anti-satellite programs, military man in space, and factors affecting public support of military and peaceful space operations. Hopeful space colonists note: "the military space-industrialization complex will challenge the peaceful uses of outer space . . ."

Space Industrialization And The Long-term Prospects For Terrestrial Civilization
AAS 77-226
Peter Vajk
$2.16
Analyzes the "limits of growth" motivation for space industrialization, system-

atically examines the evidence for it, and finds it invalid. Apparently, with advancing technology, the resources of earth are adequate, both now and far into the future. Valid motivations (from the author's point of view) are then considered. They center around space industrialization for fun and profit, leading to many new commercial ventures.

Private Enterprise in Space

Frontiers Of Free Trade
AAS 77-268
Mark Frazier
$1.88

Presents a proposal for the creation of "free zones for space, beginning with an international launch area near the equator." After examining existing legal and political hurdles to space industrialization, it is shown that free zones can circumvent them ". . . by establishing a useful political framework for the peaceful development of space" while having the beneficial side effect of encouraging "free trade and investment on Earth." These conclusions are based on historical evidence of "remarkably successful" free zone predecessors.

Drafting A Constitution For ORBIS -- Entrepreneurial Opportunity In The Provision Of Community Service In Space
AAS 77-286
Spencer H. MacCallum
$2.72

Opens with the thesis of the correlation of "despotism with hydraulic societies -- societies which were dependent for their existence upon complex, government-controlled irrigation works which constituted life-support systems not unlike, in principle, those which are now projected for space." The rationale for a proprietary space community "in which all things would be contractually administered through the customary usages of the marketplace without resource to the political relationship of sovereign and subject --acommunity without taxation or legislated laws" is presented. Historical precursors are noted. Included is "a draft of a master lease for the hypothetical space colony of ORBIS" that functions as "a constitution for a proprietary community in space."

Space Industrialization, The Challenge To Private Enterprise Capitalism
AAS 77-290
Christian O. Basler
$2.10

"No existing private enterprise business structure is suited to the task of raising and managing the capital necessary for full-scale space industrialization. Existing companies cannot undertake the necessary research and development because of the effect it would have on their present earnings and because of antitrust problems, and a new conventionally organized company would be unable to raise the necessary capital. This paper analyzes these problems and proposes a new type of business structure, called a 'staging company,' as a solution." The effects of a private community planning are also discussed.

Marketing Techniques And Space Industrialization
AAS 77-232
G. Harry Stine
$1.67

This paper presents answers to "why industrial firms are so apathetic about jumping on this wonderful new bandwagon . . ." An explanation of how "we must, in essence, market the concept of space industrialization" follows. A set of guidelines for marketing methodology applied to R & D is given.

Advanced Transportation

Advanced Launch Vehicle Systems And Technology
AAS 77-217
M.W. Jack Bell
$2.37

The potential exists for "enormous economic benefit if space cargo delivery costs can be reduced by an order of magnitude over those of the current Space Shuttle Vehicle." Many vehicle designs aimed at this end are examined. The conclusion is that "the basic capability exists today to initiate developments of an advanced launch system of greatly improved efficiency."

A Non-synchronous Orbital Skyhook
AAS 77-223
Hans Moravec
$2.02

A rotating satellite in a stable, low earth orbit about the equator, with 2 identical long filaments extending in opposite directions acts like "two spokes of a giant wheel rolling around the equator . . . canceling horizontal orbital motion during the contacts."

What's Available from the L-5 Society?

Books:

The Hunger of Eve, A Woman's Odyssey Toward the future, Barbara Marx Hubbard Stackpole Books, Hardbound. 1976	B1	$ 8.00	*(.10)*
The High Frontier: Human Colonies in Space, Gerard K. O'Neill William Morrow & Co.. Hardbound. 1977	B2	$ 8.00	*(.10)*
Paperback, Bantam Book.	PB2	2.95	*(.10)*
Colonies in Space, T.A. Heppenheimer Stackpole Books, Hardbound. 1977	B3	$12.00	*(.10)*
The Fourth Kingdom, William J. Sauber Aquari Corp., Hardbound. 1975 Drop Shipped From Publisher	B4	$ 6.00	*(.10)*
War and Space, Robert Salkeld Prentice-Hall, Inc., Unbound copy. 1970	B5	$ 7.00	*(.10)*
Exopsychology, Timothy Leary Peace Press, Paperback. 1977	B6	$ 8.00	*(.10)*
Colonies in Space, Frederic Golden Harcourt Brace Jovanovich. Hardbound. 1977	B7	$ 8.00	*(.10)*
House in Space, Henry Cooper Holt. Rinehart, Winston, Hardbound. 1978	B8	$ 8.95	*(.10)*
Paperback Bantam Books	PB8	$ 2.95	*(.10)*
Space Colonies, Edited by Stewart Brand Penguin Books, Paperback	PB9	$ 5.00	*(.10)*

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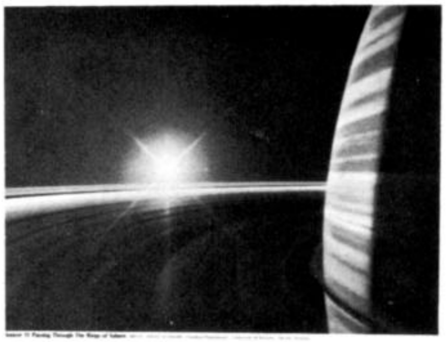

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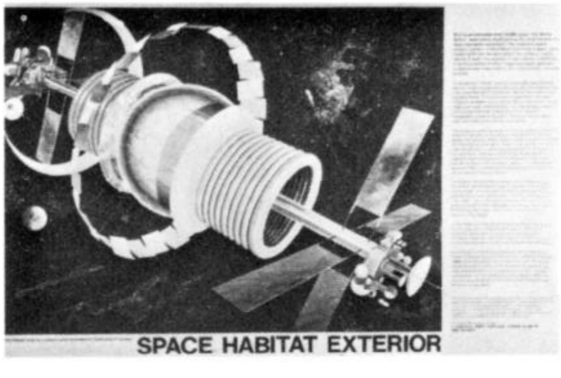

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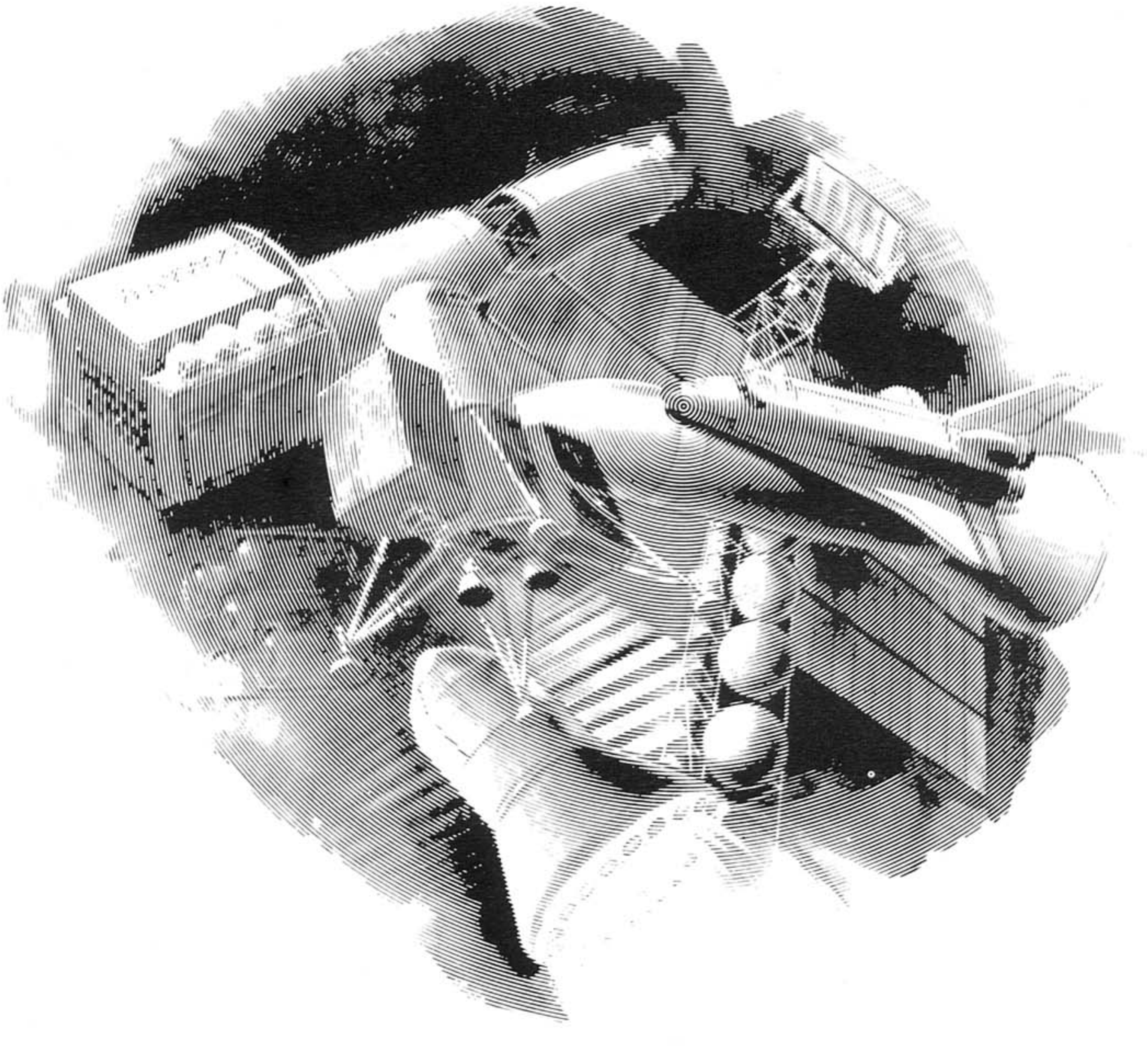

L5 NEWS

MARCH 1978

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In this issue:

1 **OMB's Plan for NASA** *Will the Enterprise by mothballed? Will we send probes to Halley's Comet and the lunar poles? Carolyn Henson reports.*

4 **Senate Symposium Commentary** *Jon Alexandr and Ken McCormick report on the Symposium on the Future of Space Science and Space Applications.*

7 **"We Have Friends In Congress"** *by Howard Gluckman.*
. . . Or Do We? *Keep up to date on Proxmire.*

8 **Testimony of Dr. Gerard K. O'Neill** *The complete testimony given by O'Neill at the Future Space Program Hearings.*

9 **News from NASA**
  United States and Soviets Talk About Space
  Space Social Impact Study
  Studies Aimed at Microwave Solar Energy

10 **Salyut-G/Soyuz-26 Joined by Soyuz-27** *Phil1 Parker gives us details on the Soviet space station.*

11 **Spacelab Candidates Chosen**
Salyut-6 Strides On *More on the Soviet space station by Phil1 Parker.*

12 **The Cosmos-929 Enigma** *James Oberg reports on a possible Soviet "space tugboat."*

13 **Military Test Pilot Astronauts Defended** *by James Oberg.*
More on Military Shuttle Pilots *by George S. Quin, Jr.*

14 **Inside the L-5 Society**

16 **Letters**

Front Cover: A "heliogyro" solar sail approaches Halley's Comet, due to enter the inner solar system in 1986. Its next scheduled visit is in 2062. See related story page 1. *(Artwork courtesy Jet Propulsion Laboratory.)*

Back Cover: Schematic representation of the solar system showing the sun, the orbit of the Earth, the orbit of Halley's Comet, and the trajectory a solar sail mission would follow in order to catch up with the comet. *(Artwork courtesy Jet Propulsion Laboratory.)*

OMB's Plan for NASA

Enterprise, Halley's Comet Mission, LPO to Bite the Dust?

by Carolyn Henson

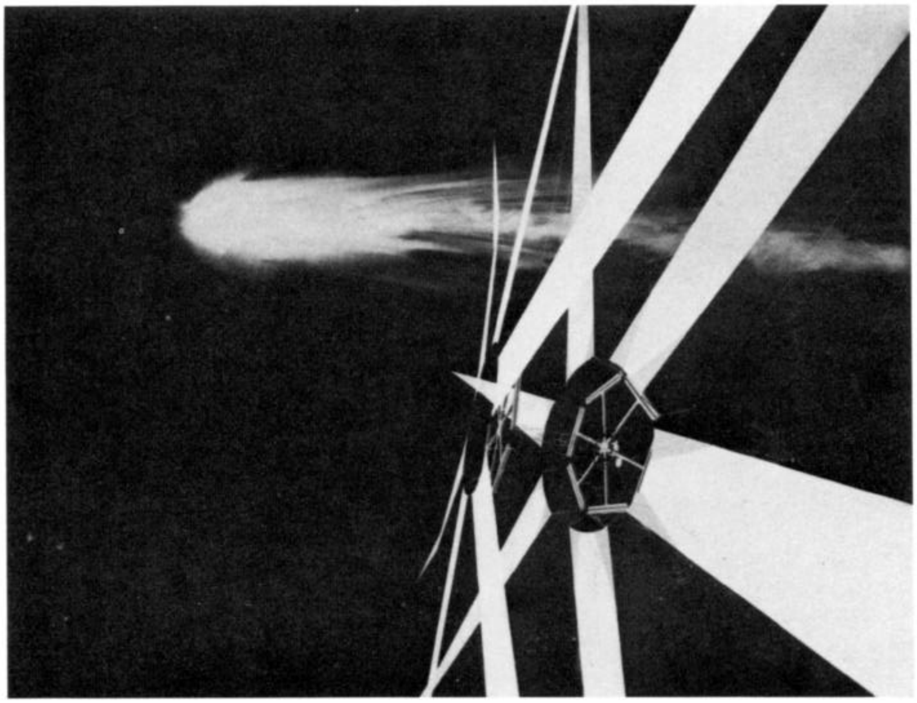
If the Office of Management and Budget (OMB) has its way, it looks like slim pickings for NASA in fiscal year 1979. OMB guidelines allow $4.371 billion for NASA's budget. This represents an 8% increase over last year's budget, barely enough to keep pace with inflation.

Budget increases are slated for the Jupiter Orbiter Probe, solar-polar out-of-ecliptic mission, Earth radiation budget spacecraft, halogen occultation experiment and solar mesospheric explorer. On the other hand, OMB decided to ground the Enterprise and decrease spending on Earth resources and communications, space transportation advanced planning and solar power satellites. The Halley's Comet mission will be cancelled, and the Lunar Polar Orbiter (LPO) failed to win approval for the third year in a row.

The Lunar Polar Orbiter is considered a vital step in developing extraterrestrial resources. Scientists suspect that glaciersof ice, nitrogen and carbon dioxide may be hidden in permanently shaded areas of the Moon's poles. The LPO would be able to detect and locate such glaciers, which, if they exist, could provide space settlers with elements which are almost totally non-existent on the lunar plains. Otherwise, settlers will have to import hydrogen, nitrogen and carbon from Earth at great expense.

Space industrialization and settlements may suffer a delay if LPO misses the boat again this year. However, if the Halley's Comet Mission gets the gate, we're going to have to wait another 76 years after its visit in 1986 in order to see close up motion pictures of gossamer veils boiling off the solar system's most spectacular comet.

The only other comet whose arrival date is expected before the end of the century is Comet Encke. (Other comets, "unexpected visitors," will almost surely show up, but we will only have a few months warning of their arrival -- too short a time for a spacecraft to-catch up with one.) Comet Encke has been in the solar system a long time, so long, in fact, that it has become a burnt-out rock with no hint of the flaming tail which has made Halley's Comet an object of fear and beauty. But OMB wants us to check out Encke instead. Sigh.



Halley's comet: wait until 2062 for a closeup view?

Enterprise: headed for the hangar -- permanently?

NASA Budget Plan

Space Transportation Systems

	(Thousands of Dollars) FY 1978	FY 1979
Space Shuttle	**1,349,2OO**	**1,439,300**
Design, development, test and evaluation	(1,307,500)	(985,300)
Orbiter	800,500	536,500
Main engine	219,900	176,700
External tanks	82,200	80,500
Solid rocket boosters	97,300	63,500
Launch and landing	107,600	128,100
Production	(41,700)	(454,000)
Orbiter	38,700	397,000
Main engine	3,000	18,000
Launch and landing	- -	11,000
Spares and equipment	- -	28,000
Space Flight Operations	**267,600**	**311,900**
Space transportation system operations capability development	59,700	110,500
Development, test and mission operations	176,400	163,000
Advanced programs	10,000	5,000
Space transportation system operations	17,700	33,400
Planning and program integration	4,000	- -
Expendable Launch Vehicles	134,500	76,500
scout	17,000	16,000
Centaur	55,900	21,000
Delta	55,300	38,600
Atlas-F	6,300	- -
TOTAL SPACE TRANSPORTATION	**1,751,500**	**1,627,700**

Space Science

Physics and Astronomy	**224,200**	**265,500**
High energy astronomy observatory	18,400	11,400
Solar maximum mission	30,600	16,200
Space telescope development	36,000	79,200
Solar polar mission development	- -	13,000
Shuttle/Spacelab payload development	28,900	38,300
Explorer development	23,896	29,800
Mission operations and data analysis	27,004	32,400
Research and analysis	33,400	35,900
Suborbital programs	26,000	29,300
Lunar and Planetary Exploration	**147,200**	**167,100**
Pioneer Venus	18,100	- -
Voyager	- -	- -
Jupiter orbiter/probe	20,700	78,700
Mission operations and data analysis	84,500	84,400
Research and analysis	23,900	24,000
Life Sciences	**33,300**	**40,600**
Life sciences flight experiments	9,000	12,400
Vestibular function research	1,500	3,800
Research and analysis	22,800	24,400
TOTAL SPACE SCIENCE	**404,700**	**513,200**

Space and Terrestrial Applications

	FY 1978	FY 1979
Space Applications:	**234,600**	**274,300**
Earth Resources Detection and Monitoring	(106,945)	(151,500)
Landsat-C	3,200	700
Landsat-D	48,200	97,500
Shuttle/spacelab payload development	3,370	6,000
Shuttle/spacelab mission design and integration	2,240	6,900
Integrated payload planning	(4,000)	4,000
Applications research and technology development	49,735	36,400
Follow-on data analysis and operations	200	- -
Earth Dynamics Monitoring and Forecasting	**(7,200)**	**(8,600)**
Tectonic plate motion	2,200	2,100
Applications research and technology development	3,100	5,400
Follow-on data analysis and operations	1,900	1,100
Ocean Condition Monitoring and Forecasting	**(16,950)**	**(12,400)**
Seasat-A	11,400	3,000
Applications research and technology development	2,750	4,200
Follow-on data analysis and operations	2,800	5,200
Environmental Quality Monitoring	**(26,190)**	**(20,200)**
Nimbus-G	13,900	2,800
Halogen occultation experiment	- -	6,100
Shuttle/spacelab payload development	3,140	2,900
Applications research and technology development	8,150	7,400
Follow-on data analysis and operations	1,000	1,000
Weather Observation and Forecasting	**(25,115)**	**(22,600)**
Tiros-N	4,100	- -
Shuttle/spacelab payload development (ACPL)	2,700	4,400
Global atmospheric research program	5,000	5,800
Severe storm research program	5,600	6,500
Global weather program support	5,815	5,100
Follow-on data analysis and operations	1,900	1,000
Climate Research	**(2,500)**	**(12,200)**
Earth radiation budget satellite system	- -	8,000
Applications research and technology development	2,500	4,200
Materials Processing in Space	**(15,200)**	**(20,400)**
Space processing applications rocket project	3,900	3,600
Applications research and technology development	5,000	4,400
Shuttle/spacelab payload development	6,300	12,400
Space Communications	**(21,200)**	**(22,000)**
Search and rescue mission	5,600	8,000
Shuttle/spacelab payload development	1,000	1,200
Technical consultation and support studies	3,100	3,100
Application research and technology development	7,700	5,200

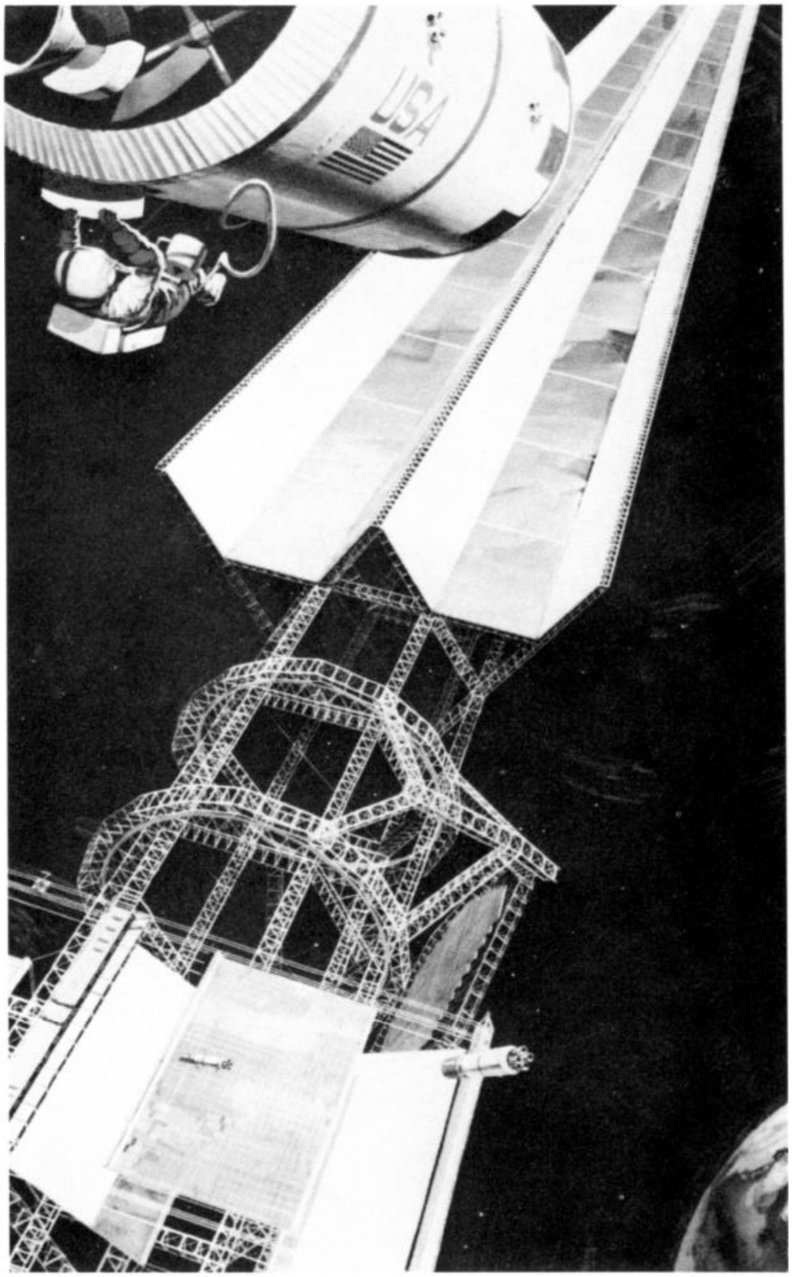
	(Thousands of Dollars) FY 1978	 FY 1979
Follow-on data analysis and operations	3,700	4,500
Cooperative applications satellite-C	100	- -
Applications Explorer Missions	**(13.500)**	**(4,200)**
Heat capacity mapping mission	600	300
Stratospheric aerosol and gas experiment	2,400	- -
Magnetic field satellite	10,500	3,900
Technology Utilization	**9,100**	**9,100**
Industrial applications	3,715	3,715
Technology applications	4,110	4,110
Program control and evaluation	1,275	1.275
TOTAL SPACE AND TERRESTRIAL APPLICATIONS	**243,900**	**283,400**

Aeronautics and Space Technology

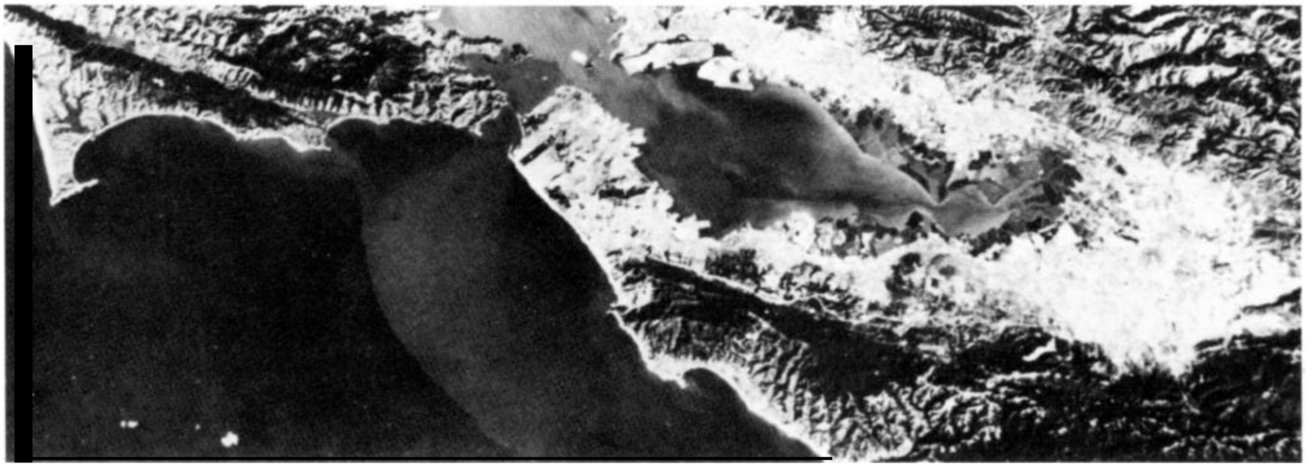
Aeronautical Research and Technology	**228,000**	**284,100**
Research and technology base	96,660	109,200
Systems studies	3,000	3,000
Systems technology programs	75,090	85,645
Experimental programs	51,250	66,255
(Aircraft energy efficiency technology included in systems technology and experimental programs)	(70,200)	(97,400)
Space Research and Technology	**97,700**	**108,300**
Research and technology base	65,900	71,700
Systems studies	2,000	2,000
Systems technology programs	5,600	7,900
Experimental programs	15,000	17,700
Low cost system program	9,000	9,000
Energy Technology Applications	7,500	3,000
TOTAL AERONAUTICS AND SPACE TECHNOLOGY	**333,200**	**375,400**

Space Tracking and Data Systems

Tracking and Data Acquisition	**278,300**	**305,400**
Operations	228,600	254,200
Systems implementation	40,400	41,300
Advanced systems	9,300	9,900



Large space structures: not this time, folks.



View of San Francisco: California's budget surplus nearly equals NASA's proposed budget.

Senate Symposium Commentary

by Jon Alexandr and Ken McCormick

The eventual mass movement of humanity into space was an idea that seemed to be almost taken for granted by participants in the Senate Science, Technology and Space Subcommittee's February 7 'Symposium on the Future of Space Science and Space Applications." The emphasis, however, was on the potential economic benefits to the earth-bound citizen of the industrialization of space.

Apart from discussion of Lunar, Martian, and space colonization, speakers tended to focus on applications of space technology which have been studied in some detail, already. Large, heavy communications satellites, for instance, would make possible electronic mail transmission, delivery of health care to remote areas, electronic commuting by teleconferencing, wrist radios, personal emergency "panic buttons" for summoning help, and continuous electronic tracking of nuclear fuel shipments. A global information network could make the contents of the great libraries of the world available for electronic retrieval by receiving stations in homes and small libraries.

Observation satellites could provide instant dial-up images to individual farmers and other users, provide information for earthquake prediction, monitor pollution, fisheries, and crops, and detect forest and brush fires within seconds after they start.

Lifesaving chemicals and super-strong metals which cannot be produced in the strong gravitational field of the earth could be manufactured in space.

Satellite solar power stations were discussed, as well as the possibility of microwave transmission, via satellite, of energy produced in remote areas of the earth.

Dr. William M. Brown of the Hudson Institute saw space tourism as a trillion-dollar growth industry of the twenty-first century. Lower and lower transportation costs to orbit will eventually make space travel as accessible to the ordinary citizen as long-distance travel is today, said Dr. Brown.

Dr. George Van Reeth, director of administration of the European Space Agency, said that the sponsor nations of ESA had great interest in the commercial applications of space, as well as in resource satellites. ESA will seek an increase in its $600 million budget, and will continue to cooperate in the future "mainly, but not exclusively" with the U.S.

The large initial capital investment of space industrialization ventures was a source of concern. For instance, the cost of orbiting a satellite which would make available a "Dick Tracy" wrist radio system to the public was seen as about a billion dollars by Ivan Bekey of Aerospace Corporation. However, with the wrist radios available to consumers at about $10 each, and a charge of 10 cents Per minute for use of the satellite facilities, the billion-dollar satellite should produce about a billion dollars per year in revenues, said Mr. Bekey.

NASA administrator Frosch placed the cost of an SSPS system at $500 billion, and said that while this was comparable to the capital outlay for other systems, such as coal and nuclear fission, the other systems could be purchased in small chunks, whereas the SSPS system would have to come all in one package. If he could not get agreement on relatively cheap information and communications satellites, Frosch asked, how was he ever going to get the huge investment for SSPS? Other speakers, such as Space Global president Krafft Ehricke, stressed that we would approach our large goals in space by small, profitable increments.

Economist Dr. Klaus Heiss said he regarded SSPS as "a feasible option to pursue" once research on large structures in space has been carried out. He noted that in the case of fusion research we are putting $400 million this year "into the pursuit of a technology that by all economic estimates will at that be operationally useful by the year 2025 or maybe the year 2035. Space-based power systems . . . certainly have a similar potential over such a long time horizon. We should pursue them, but we are not putting any similar funding into the pursuit of a space based power option."

A subject of great concern to speakers and senators, alike was the problem of the shrinking NASA budget. Dr. Heiss suggested that if a poll were taken which first explained to respondents that we are spending $126 billion for defense, and $160 billion for the department of Health, Education and Welfare, and then asked how much we are spending for space, most people would guess that we are spending tens of billions of dollars, rather than the four billion which is actually allocated.

It was felt that there is wide support in Congress and among the public for the space program, but that NASA projects always ran into trouble with the "budgeteers" in OMB and the congressional appropriations committee. The antidote for this was seen to be congresspersons and the public becoming aware of practical economic benefits which derive from the space program. "Right now, space is the only major technological area where we are creating the leading edge of technology. Every industry in this country benefits over a relatively short period of time from the fact that we stay at the leading edge of technology," said Senator Harrison Schmitt.

Krafft Ehricke saw the center of world power as shifting away from Western civilization as non-Western populations expand and the third world nations industrialize. He pointed to foreign imports which are currently driving the U.S. out of some industries as indicative of the shape of things to come. To maintain a competitive economy, said Ehricke, the U.S. must maintain technological pre-eminence. A "Space America," using lunar resources and the industrial potential of space was seen as a road to jobs and job security.

Dr. Brown pointed out that there are many other nations in the world today, such as Japan, Brazil, or China, which would be capable of becoming the number one space power within twenty-five years, should they choose to invest in that direction.

"I think that it is self-interest -- hard-nosed economic interest -- that . . . today offers the United States an opportunity in space," said economist Heiss. "I do think, right now, we are underinvesting in space as to what the potential promise might be of space. Once economics takes over . . . economic self-interest will get us to the great vision that was offered by some of the other speakers, today."

Senator Donald Riegle, a rapidly-rising politician with presidential ambitions, drew flak from Harrison Schmitt and Dr. Frosch when he announced that although he had taken his son to see "Star Wars" for the sixth time, he wondered whether we should be spending so much money on space when there is so much to be done here on earth. Dr. Frosch argued that we will not solve the problems which now face us with the same set of beliefs and capabilities which created the problems to begin with. Just as has been the case throughout history, said Frosch, we can expect new definitions and new solutions to problems to come from totally unexpected areas as we gain new knowledge and new capabilities.

The concepts which have been put forward by Gerard O'Neill were referred to several times during the symposium, although Dr. O'Neill was unfortunately not present to explain his own views.

Professor James Arnold of the University of California termed the prospect of lunar mining "very exciting," and found the study which has been done so far "encouraging." He said he thought it was something which should have "enormous interest" for us.

Dr. Brown of the Hudson Institute, on the other hand, said he agreed with Dr. Frosch "that we as engineers don't want to spend too much time in the near term working out those problems." He acknowledged that "space colonies are a very popular item among certain select groups today -- 'cults,' if you wish," and that some of the work which has been done by "interested young students" as a hobby has been a "bonus" to NASA. "They're building these little mass drivers . . . and they're studying the various problems that they can forsee, and thinking about how you get solutions and, as I understand, most of them do it for free, and some of the work I think is really very good work."

Dr. Brown made it clear that he expected O'Neill-type colonies to be built, regarding the timing as the only real question. After pointing out that Dr. O'Neill sees colonies as feasible "by the end of the century," Brown said that he disagrees with this, believing that colonies "might not be feasible except after 50 years."

Brown acknowledged O'Neill's work in the area of a feasible time scale, however, saying, "I'm not putting myself up against him, because I certainly don't know what I'm really talking about, except as second-hand information." Brown did not make it clear what the basis was for his contradiction of O'Neill's time scale.

In his summary remarks, subcommittee chairman Adlai Stevenson III questioned the wisdom of the Carter administration's proposal to reduce the size of the space shuttle orbiter fleet to four orbiters. Pointing out that Congress authorized a fleet of five orbiters last year, Stevenson made it plain that he would like to see funds for the fifth orbiter restored to this year's budget. Stevenson noted that there was some question as to whether four orbiters would be enough to perform the tasks already envisioned for the 1980's, and that procurement of a fifth orbiter at a later date would cost $200 million more than the procurement of the fifth orbiter on the original schedule. He suggested that the proposal to cut the orbiter fleet could prove to be "a 200 million dollar mistake."

In his final remarks, Sen. Stevenson returned again to a theme that he had repeatedly stressed throughout the symposium; the current experimentation with space warfare techniques, he said, could lead to an expansion of the arms race into space. This, he felt, would be a development which could interfere with all the great goals that had been discussed.

"We Have Friends in Congress"

by Howard Gluckman

"We have friends in Congress!" With those words, space consultant G. Harry Stine introduced his talk on space industrialization at the AIAA/World Future Society symposium: "Our Extraterrestrial Heritage -- From UFOs to Space Colonies." The program took place at the California Museum of Science and Industry on Saturday, January 28.

Mr. Stine refrained from reading his prepared paper, and instead told the suddenly awakened audience about the recently completed hearings on "Future Space Programs" in the House Committee on Science and Technology. He told of the good reception that he and fellow witnesses Gerard O'Neill, Barbara Marx Hubbard, and other space industrialization proponents received, and of the chastisements that met Carter administration representatives Frank Press and Robert Frosch.

Stine then read the testimony that he presented to the committee. In it he called for major changes and improvements in the way our space endeavors are handled. He urged Congress to let NASA do what it does best -- research and development, and space science; and to let them contract out or relinquish control of what it does poorly -- public relations, and management of an operational space transportation system. His talk was received enthusiastically by the symposium audience.

Mr. Stine's speech was the highlight of an otherwise ordinary symposium. The morning program concentrated on UFOs. The topics ranged from close encounters (the Zeta Reticuli episode), to instrument detection of UFOs, to the Search for Extraterrrestrial Intelligence (SETI) project. German rocket pioneer Krafft Ehricke gave a speech on space industrialization that was unfortunately cut short by lack of time. Ehricke was followed by Charles Gould of Rockwell International who presented a long discussion of the details of space industrialization. He was followed by Stine and Richard Johnson, Deputy Director of the NASA/Ames Space Colonization study. Johnson, who was put on the defensive by Stine, tried to bring everyone down to Earth by detailing the problems that have yet to be solved, but it was to no avail. The program ended with a space-scenes slide show presented by the museum, and a special videotape showing of a television program produced by the World Future Society on the public's reaction to space.

View of North America.

. . . Or *Do We?*

Dear Mr. Carley:

I appreciate hearing from you about the CBS program 60 Minutes and my comments regarding space colonization.

My position is based on economics and good sense. A plan to place 100,000 or one million people in space on a permanent basis cannot be justified by any known analytical study incorporating cost effectiveness criteria. On earth we have land, water, and an environment that if not plentiful at least is available for use without artificial construction. A space station for one million inhabitants would require financial resources beyond anything currently imaginable without any prospect of economic return.

Therefore, I have concluded that any funds spent on space colonization is simply a waste given the massive problems remaining to be solved here on earth.

The Administator of NASA has informed me that their planning for the foreseeable future is NOT directed at permanent settlements of people in space since there are no calculations of the benefits that could be derived. He also has said that this space plan has no priority at NASA.

I agree with both of these positions. Our limited federal funding can be put to much better use here on earth.

William Proxmire.
U.S. Senate

Testimony of Dr. Gerard K. O'Neill

in support of House Concurrent Resolution 451

before the committee on Science and Technology, House of Representatives, Jan. 25th, 1978

Thank you for the opportunity to present these views. I'm here to report to you on great progress that's been made, on a unique opportunity that we now have to benefit this country and the world, and finally to point to a very big job still to be done. At the start I want to thank the several Congressional committees that have recognized the significance of this work from the start; and the hundreds of scientists and engineers in government, the universities and industry that have brought the paper study phase to a most successful conclusion; and the private citizens' groups, of which Mrs. Hubbard's is an outstanding example, that have supported this work from its first public discussion.

Humanity is now faced with urgent problems that far transcend in scope and timescale the duration of one American presidency. How to solve growing shortages of energy, how to reverse the present worldwide sink toward poverty, hunger, and military confrontation over diminishing resources. There are two alternative approaches:

One is to accept the inevitability of catastrophe, and do nothing except to monitor global resources, slow the pace of decline by conservation, and be ready to accept the harsh limits on human freedoms that an eventual global steady-state will impose. That is the counsel of the "limits-to-growth" apologists. It was expressed well in the article "After the Deluge, the Covenant" in Saturday Review-World. That article imagines as a good solution a history of these next decades in which 65 million people die by starvation, many millions more die in nuclear wars, and ultimately nations such as our own surrender sovereignty to a worldwide Authority with control over all our nuclear weapons and power to equalize world food supplies by shipping American food abroad with or without our consent. Let me emphasize that I share with many people a belief that a reduction of population growth rates is a good thing. The fact is, though, that the only peaceful way that reduction has ever come about is by individual free choice, in an affluent, well-educated society. No one who calls himself human could regard as an acceptable alternative the enforced death of millions of children by famine.

The second approach to the global problems is, I believe, far more in keeping with our American tradition. That is to use all the science and engineering knowledge we now have in a vigorous, immediate attack on these urgent problems, in a way that will leave us the individual freedoms we have fought for during the past two hundred years. And in the course of that solution, to preserve and protect the fragile biosphere of our Earth.

The fatalism of the limits-to-growth alternative is reasonable only if one ignores all the resources beyond our atmosphere, resources thousands of times greater than we could ever obtain from our beleaguered Earth. As expressed very beautifully in the language of House Concurrent Resolution 451, "this tiny Earth is not humanity's prison, is not a closed and dwindling resource, but is in fact only part of a vast system rich in opportunities, a high frontier which irresistibly beckons and challenges the American genius."

My own background is in pure science, in the search for scientific truth such as the measurement of the size of the electron. Yet I believe that efforts of pure science, with no practical application for many decades, must be accompanied by the immediate application of science wherever possible to humanity's urgent problems.

I'm reporting on an apparent solution to the limits-to-growth problem, based on fundamental facts of science that will never change: First, that while we search desperately for new energy resources here on the Earth, a few thousand miles above our heads there streams by constantly, night and day, a flood of high-intensity solar energy far greater than we could ever need.

Second, that already we know of materials resources, for large-scale industrial activities in space, thousands of times greater than we could ever obtain from the Earth without despoiling it completely. We spent, in today's dollars, fifty billions on the Apollo project. As a result we know that the lunar surface is one third metals, usable for manufactured products, one fifth silicon, ideal for solar cells and electronics, and more than forty percent oxygen, essential in life-support. I say we should use that knowledge, not throw it away or ignore it.

Already we know that there are special groups of asteroids, with orbits close to the Earth, that are rich not only in the minerals found on the Moon but also in the organic-chemistry building-blocks needed for a complete industrial economy.

Last of three basic scientific facts, we know that the cost in energy to transport materials from the lunar surface into free space, where it can be used by a totally solar-powered industry, is less than a twentieth as large as the energy cost to transport similar materials up from the Earth.

It makes sense to put at least a small fraction of our total national effort, perhaps one part in ten thousand of our federal budget, into exploring over the next several years how we can use these basic scientific facts to break through the limits to growth and solve the urgent worldwide problems.

In addition to the eternal truths of science, there are facts of current events that must be heeded in any practical program.

First, the Shuttle is the only vehicle system that will be operational for at least the next decade, and that can give us a toe-hold on the High Frontier. If used efficiently, as an airline uses its aircraft, the Shuttle could transport a little less than two thousand tons of equipment per year into orbit.

Second, events are changing much too rapidly for us to forsee now just which industrial products will be the first to benefit from a program of manufacturing in space from nonterrestrial materials. Right now the idea of satellite solar power stations, in synchronous orbit where the sun always shines, beaming down low-density microwave energy for conversion to ordinary electricity for Earth, looks like an ideal candidate. The need is great, and the demand can be estimated as a worldwide market of over 200 billion dollars by the turn of the century. Clearly the use of materials already at the top of Earth's gravitational mountain could reduce transport costs by a large factor, as well as avoiding environmental impact questions that would be raised by the alternative of launching rockets through the atmosphere from Earth, with a total traffic that would be two thousand times larger in tons per year than the shuttle traffic.

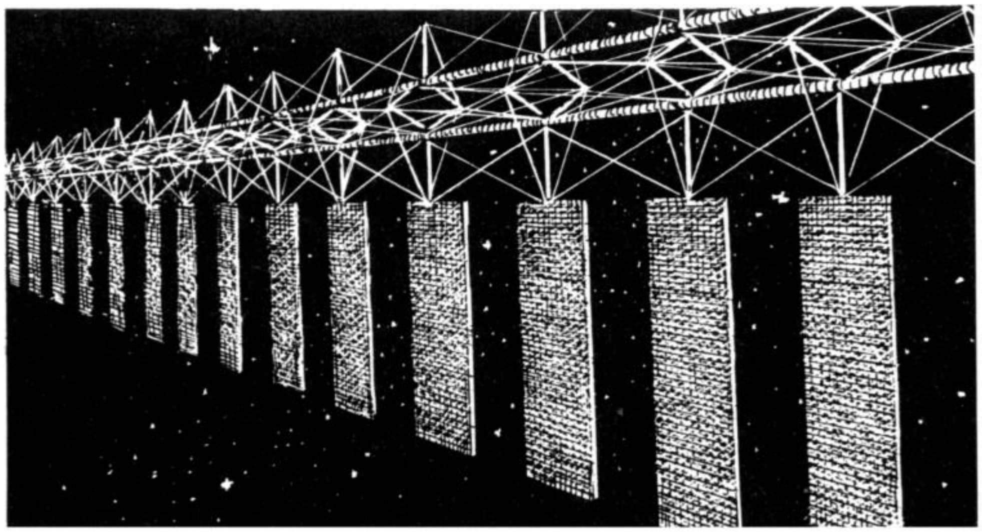
But it may be that by the time the High Frontier is opened the satellite power concept will be dead, either because of some insoluable problem in the engineering, or because of environmental impact, or because during its development some other energy technology will have become less expensive. It makes sense therefore to preserve generality in the assault on the High Frontier, to develop the fastest, least expensive approach to nonterrestrial resources of energy and materials for use in space. By the time we have broken through the limits to growth, it will be clearer how first to exploit the breakthrough.

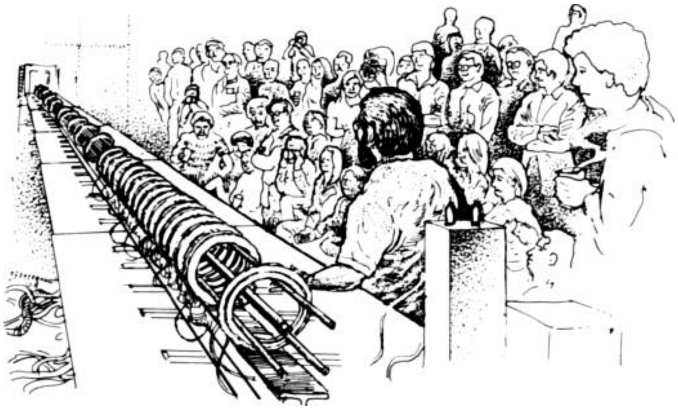
In the past three years there has been great progress in the scientific and engineering studies of the High Frontier concept, and that progress is now well documented, in proceedings of conferences published by the American Institute of Aeronautics and Astronautics, in publications of the Edison Electric Institute, and in a disarmingly slim volume with the technical articles from a 1976 NASA study. These articles have gone through the entire scientific process of peer-review. Last summer a massive study more than four times as large as this one was completed, and its results, in 16 peer-reviewed technical articles, will shortly be published by NASA.

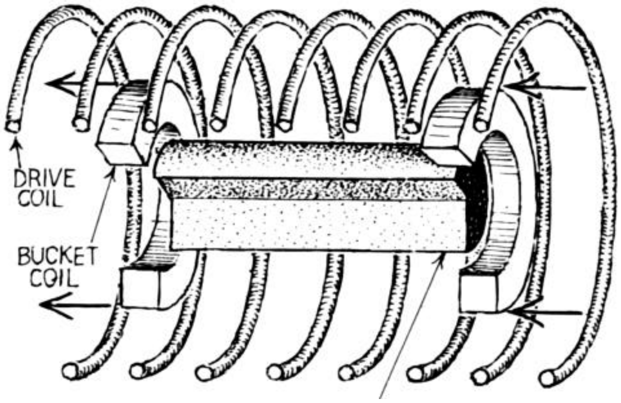
Our present best estimate of the quickest, most economical road to follow is contained in that final study, and is condensed in a special section of the journal "Astronautics and Aeronautics" to be published this March. To show you how much has been accomplished with very little, here are a few pictures of one special device that may be a key to reaching the High Frontier within the limitations of the Shuttle. The device is a new type of electric motor called a mass-driver. It would be used initially as a reaction engine, a tugboat to lift accumulated shuttle payloads of equipment to geosynchronous and lunar orbit. A first working model has already been built, by a group of student volunteers under the direction of Dr. Henry Kolm. The machine was demonstrated at several locations, one of them the final briefing at our 1977 NASA-Ames study. The tests were entirely successful, and the model accelerated a one pound load from zero to 85 miles per hour over a six-foot length.

A mass-driver reaction engine could be carried into orbit in sections, by the Shuttle, to an orbital workbench of a kind already studied by NASA-Johnson Space Center. The reaction engine could lift over 700 tons of accumulated shuttle payloads to lunar orbit, using powdered external tanks from the shuttle to provide the push. Unless we use them those tanks will otherwise be allowed to burn up in the atmosphere over the Indian ocean, an unpardonable waste.

Less than two years' worth of shuttle payloads, lifted to lunar orbit by the mass-driver, would give us all the equipment needed for a lunar base, and all the propellant to soft-land it on the lunar surface. A second mass-driver would be part of that equipment. Located on the lunar surface, it could bring out 30,000 tons/year of lunar materials to a precise point in space; that is, twenty times as much tonnage as the shuttle could lift. One year more of equipment


Tugboat in space: the mass driver.

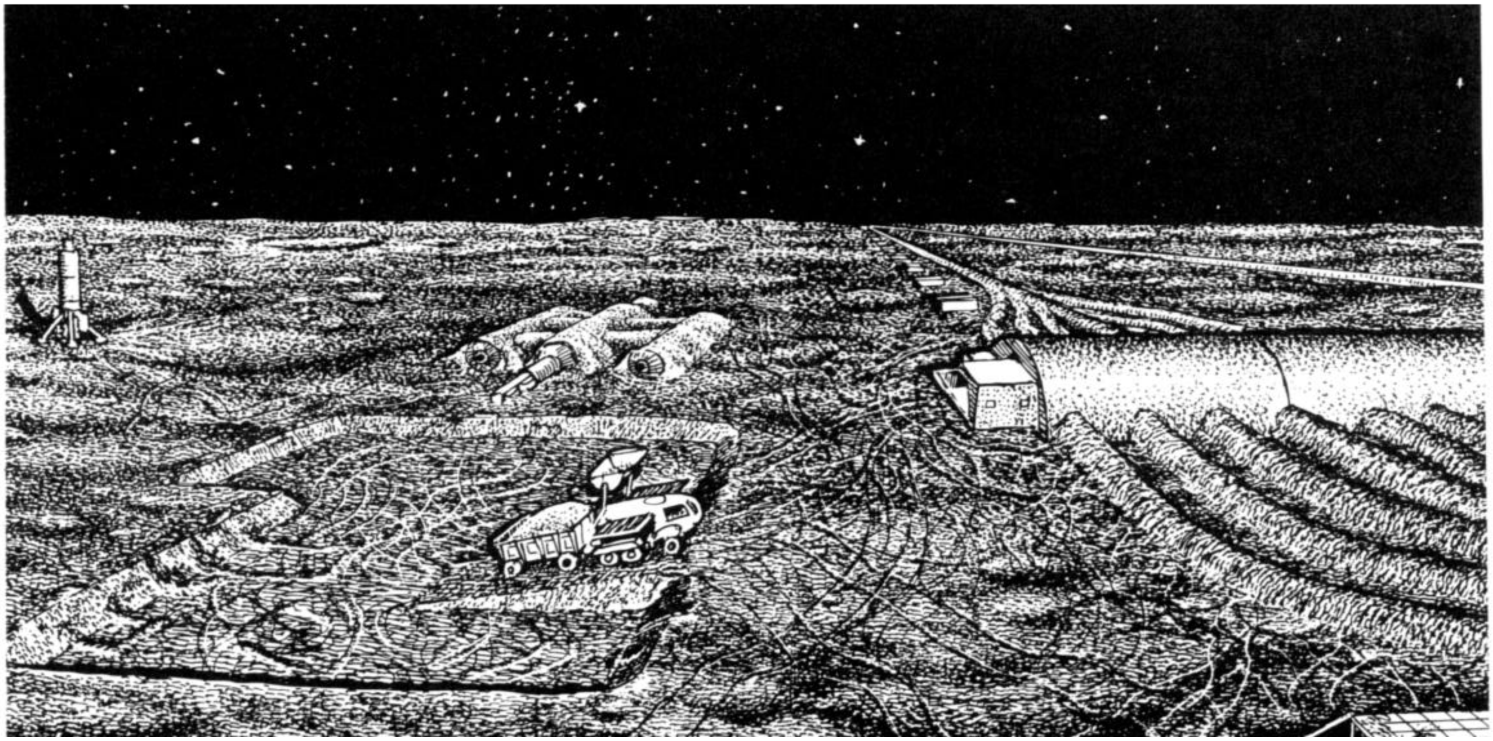

High-acceleration working model of mass-driver.



Mass-driver: Current in drive coils makes magnetic field that pushes on currents in bucket coils, giving acceleration.

Lunar mine and mass-driver. Crew habitat and machinery tunnels covered by lunar soil for shielding.

Illustrations courtesy Don Davis. They appear in the paperback version of **The High Frontier**, *by Gerard K. O'Neill, Bantam Books 1978.*



lift would give us the capability of chemical processing of those lunar materials in space.

We don't need large-size space-colonies as a precondition for that industrial activity; studies show that comfortable apartments can be built within the shuttle external tanks, for use both in space and on the lunar surface: it appears that within a time of seven years from first liftoff, in a traffic model of 60 shuttle flights per year, we could bootstrap our way to a productivity in space of more than two hundred thousand tons per year of finished products, from about three times that quantity of raw materials.

If those products were the components of solar power stations, to be sold to all those countries that need energy, their value would be over twenty billion dollars per year in hard-currency earnings. That should mean a lot to our country, that had a deficit just this past November of over three billion dollars in balance-of-payments.

Because of the shuttle and our headstart in space technology, the United States is now in a better position than any other nation to seize this opportunity and profit by it, while still benefiting other nations. But no opportunity waits forever, and the chance we now have can be lost within a few years. The Russians didn't seriously compete with Apollo, but quietly they've now gone far ahead of us in studying the maintenance of a workforce in space for long periods of time. They've completed tests lasting over a year, in which groups of three people grew wheat and other grains in a closed environment, baked their own bread, and lived comfortably. In the Salyut space station, food plants have already been grown, and several of the life-support systems have already been operated successfully in closed-cycle form. What we're still arguing about, they're already doing.

That isn't our only competition. Japan has averaged a 10% annual economic growth rate for decades, and markets its products aggressively and successfully here in America. As a result, by 1990 Japan's standard of living is calculated to surpass our own. It may be no accident that of the many translations of my book, *The High Frontier,* the first to be completed and published is the Japanese edition.

If I may give some good news, *The High Frontier* recently won the Phi Beta Kappa award as the best science book of 1977. I don't think it's because I'm another Ernest Hemingway, but rather that the basic idea is a powerful one.

We need not fear that these concepts are of no interest to the general public. Just during a few weeks there are, for example, the excellent Associated Press article announcing the House Concurrent Resolution, a New York Times magazine article to be published next Sunday, a NOVA educational television one hour special to be shown on February 2nd, three BBC Television specials, and dozens' of other articles and interviews.

We have accomplished a great deal so far on a limited amount of funding. If the whole NASA budget is represented by a stack of books two feet high our share corresponds to only a single sheet of paper. In the uncertain first months of the new Administration, even that small share has been reduced; fortunately, private donations to the Space Studies Institute in Princeton have allowed us to push ahead vigorously even in the absence of funding from the executive branch.

It is premature to talk of exact schedules and exact plans. During these next three years we need most of all a strong effort on working models, bench-top pilot-plants, and critical-path analysis. I recommend that Congress entrust that effort to the guidance of the Universities Space Research Association, a group of 55 universities with headquarters in Houston, Texas. In parallel, we need an unbiased, objective, independent analysis of what the High Frontier program could do for this country, in jobs, economic growth, and the preservation of the environment. The Office of Technology Assessment is well able to carry out such an analysis.

With this intensive effort, by 1980 we should be in a position to decide whether to reach for the High Frontier, or whether to remain forever limited by the resources of our planet. That reach would then require an Apollo-scale program of engineering and science, but if it is as successful as the Apollo project was, by the late 1980's the first lift of equipment could begin, and productive payback could occur by the 1990's. We can only know for sure that if we close off that option, there is no alternative but the bleak, authoritarian future of the steady-state society.

News from NASA

United States and Soviets Talk About Space

NASA and the Soviet Union's Academy of Sciences held discussions Nov. 14 to 17 in Moscow concerning further cooperation in space. The talks are a result of an agreement reached by NASA and the Soviet Academy of Sciences May 11, 1977, following a meeting of representatives. of the two agencies in Washington.

The U.S. delegation was headed by Dr. Noel Hinners, Associate Administrator for Space Science, NASA headquarters. The Soviet Delegation was led by Dr. Boris Petrov, Chairman of the Intercosmos Council of the Soviet Academy of Sciences.

The Moscow meetings were exploratory, aimed at selecting and appraising joint scientific programs for the 1980s that might be mutually advantageous. Emphasis was on 'fields of study that could take advantage of the different attributes represented by spacecraft such as the U.S. Space Shuttle and the USSR Salyut.

The delegates met as two working groups; one on science and applications, chaired by Dr. Hinners, and one on operations, chaired by Dr. Glynn Lunney, manager of the Shuttle payload integration and development program office at NASA's Johnson Space Center.

The two working groups will seek to fix upon scientific subjects for possible experimentation that might benefit from the flexible delivery capability and large capacity of the Space Shuttle and the capability for longer stay time in orbit represented by the Salyut.

In another U.S.-USSR cooperative space program, the eighth annual meeting of the NASA-Soviet Space Biology and Medicine Working Group was held Nov. 19 to 25 at NASA's Wallops Flight Center. Before the formal meeting, a workshop on simulated weightlessness was held Nov. 16 to 18 in Bethesda, Md. The workshop and meeting are part of a continuing program under the 1971 Science and Applications Agreement between NASA and the Soviet Academy of Sciences.

The meeting focused on biomedical results, including the preliminary results of the Soviet Cosmos 936 flight on which U.S. experiments were flown; a briefing from the Soviets on Salyut 5/Soyuz 19 missions; and a U.S. briefing on a Spacelab missions demonstration test. Participants discussed forecasting man's health state in weightlessness and the research approach to studying space motion sickness.

The U.S. delegation at the formal meeting was headed by Dr. David Winter, NASA director for life sciences. Dr. Rufus Hessberg, director of space medicine, headed the U.S. workshop participants. The Soviet leader at both meetings was Dr. Nikolai Gurovsky of the USSR Ministry of Health.

Space Social Impact Study

The National Aeronautics and Space Administration, with the help of a team of social scientists at Georgetown University, is starting to think about the impact of future commercial activities in space.

"Maybe we ought to try to anticipate some of the social and cultural impacts early enough to be ready for them," said a space agency official who is overseeing a $15,000 grant to the Georgetown graduate school for the project.

For a start, said Jesco von Puttkamer, the NASA official, the agency would like to find out how many scholars are interested in the social implications of the use of space.

Dr. T. Stephen Cheston, associate dean of the graduate school and head of the project, and two colleagues, Courtney Stadd and Timothy Hart, have started cataloguing social science articles dealing with space exploitation.

They are also considering starting a quarterly journal tentatively titled Space Humanization Review.

"We may have been a little bit negligent in the last three or four years," said Puttkamer, "talking about space transportation systems, getting people into space and getting the benefits of space down to Earth without being really too much aware of . . . the social needs."

Cheston said the study was focused on the problems and possibilities of the next three decades.

Studies Aimed at Microwave Solar Energy

Two studies are being conducted to determine the negative or harmful effects of transmitting solar energy in the form of microwaves to earth stations, which would convert them into electricity. Both studies are being handled by Battelle Memorial Institute's Pacific Northwest Laboratories, Richland, WA, at the request of the Dept. of Energy and NASA.

The microwave transmissions would come from a proposed series of satellites in stationary orbits around the earth. Solar energy, caught above the earth's atmosphere would be converted into microwave energy on the satellites. Researchers have calculated that 20 to 25 satellites could have provided all of the United States' power needs in 1975.

But what problems would crop up with these microwave transmissions? One Battelle study group will try to find out if any electromagnetic or radio interference trouble would stem from such transmissions. The other group will try to uncover any potential harmful effects on the earth's environment. All work is expected to be completed by September, 1978.

Salyut-6 / Soyuz-26 Joined by Soyuz-27

by Phill Parker

At 17 hrs 6 mins., Moscow time, on the 11th of January, 1978, the piloted Soyuz-27 spacecraft rendezvoused and docked with the orbiting Salyut-6/Soyuz-26 spacecraft to form a major space complex in earth orbit. The Soyuz-27 crew were Vladimir Dzhanibekov and Oleg Makarov. They joined their partners in space, Grechko and Romanenko, the latter having been in space for over a month at that stage. The two visiting cosmonauts were planning a five day stay at the Salyut-6 station, according to Soviet Union news sources. Their own ferry vehicle, Soyuz-27, docked with the hatch on the Salyut transfer compartment -- which had given trouble for an earlier mission, Soyuz-25, and which was successfully checked out by the Soyuz-26 crew during an EVA in December 1977.

After transferring from their Soyuz-27 vehicle, Dzhanibekov and Makarov joined in with Grechko and Romanenko in toasting the historic link-up with cherry juice from tubes and by holding a 15 minute television session with earth. The two visiting cosmonauts brought mail from Earth, copies of 'Pravda', letters, books and more research equipment.

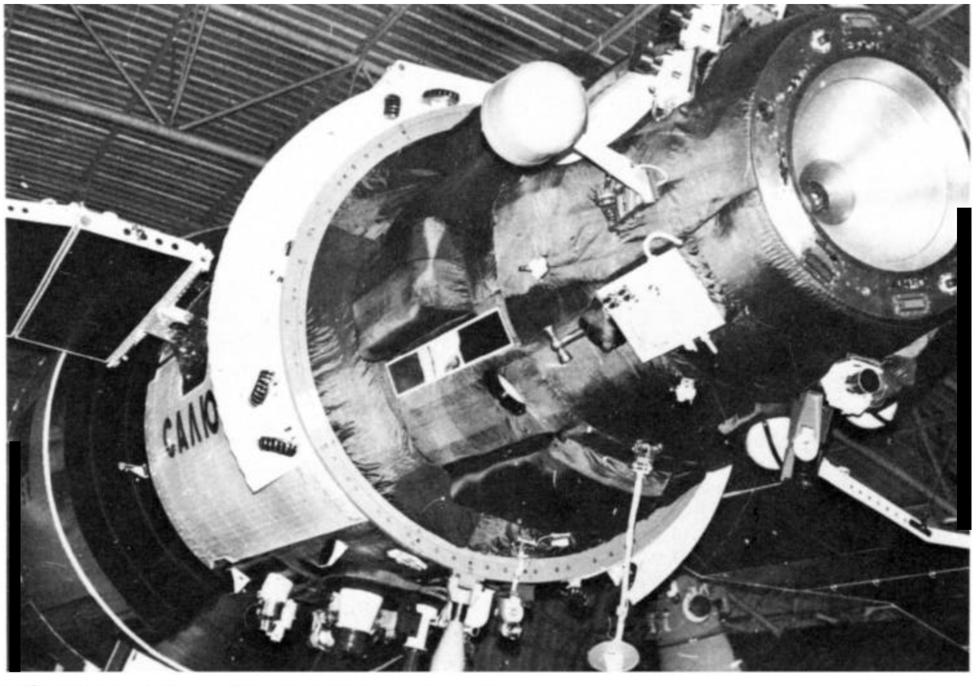
Konstantin Feoktistov, commenting upon the link-up, stated that it was another step toward creating large 'sophisticated engineering complexes in terrestrial orbit' and that these would carry out 'scientific and national-economic tasks'. On the docking, Feoktistov commented that some people had feared that multiple docking of spacecraft might lead to 'switching effects', or, break-up of already docked units. However, the Soyuz-27 docking had revealed that this did not occur and the resonance experiment, carried out by Grechko, also confirmed that this did not take place. The Soyuz-27 vehicle had been launched at 15:26 Moscow Time on the 10th of January, 1978.

Prior to the docking of Soyuz-27 with Salyut-6, the Soyuz-26 crew of Grechko and Romanenko had spent over a month in orbit. They had celebrated New Year with a fir tree and prepared a special New Year meal, as well as holding a press conference with the flight control centre. One of the flight directors, Alexei Yeliseyev noted that the operation of the 'delta' automatic navigation system of Salyut-6 was one of the most important engineering achievements of the flight.

During the first week of the New Year, the external radiation sensors had not recorded any evidence of solar flares and reported that the space weather was quiet for the station. Soviet biologists were also conducting a space experiment, called "Medusa", to do with the origin of life in the universe. The purpose of the experiment is to determine the changes caused by the spectrum of space radiations in elementary living cultures. Samples are mounted on the exterior of the space station while control samples are kept inside the station. Analysis of the samples will be carried out back on earth. Meanwhile, during the first month in orbit, life for the two cosmonauts had settled into a routine of observations and experiments, after the initial excitement of Grechko's spacewalk on the 20th of December, 1977.

The first Soviet space walk (EVA) from a Salyut space station took place on the 20th of December, 1977 when Georgi Grechko opened the hatch to begin his space walk to investigate the docking port of Salyut-6. Firstly, the crew entered the transfer compartment and put on a new type of semi-rigid, full-pressure suit, checked the autonomous life-support regeneration equipment and then closed the hatch between the transfer and working compartments. The transfer compartment was then fully depressurized. The crew worked in both illuminated and shadowed portions of the orbit. Grechko had a color television camera with him and sent back to earth close-up views of the docking elements and parts of the Salyut station. Grechko, using special assembly, control and adjusting tools, checked around the area of the transfer compartment and the docking unit, assessing the conditions of the joints, guiding pins, fasteners and sealing surfaces for damage. However, the crew was able to report that the docking unit was in working order. During the walk the two cosmonauts also checked new methods and concepts for making space walks. The space walk lasted 1 hour and 28 minutes.

In a press release Professor Konstantin Feoktistov (pilot cosmonaut aboard Voskhod-1 in October 1964) described some of the new features of Salyut-6. He noted that the addition of a second docking port had meant some design changes. This was mainly modifying the station's propulsion plant to make room for this second docking port. The two docking ports are identical in design and the automatic link-up is the same in both cases. The only difference is that the Salyut turns to the approaching spacecraft, depending upon which docking port is being used. Other innovations are that the thermo-regulating and attitude control systems are now in their final form, unlike previous missions where



Salyut space station. (photo courtesy Theo Pirard) they were experimental. The space station also has a water regeneration system and an effective portable line teletype. There are more television cameras, too. Inside, there are two black-and-white and one color, while three cameras are mounted outside. The cameras are the same as those used in the joint US/USSR Apollo/Soyuz mission. Also, more crew comforts have been added, including a small folding polythene cabin shower unit. The instrumentation has also undergone great changes making it possible to conduct more extensive and more advanced astrophysical and biological studies as well as investigations of natural resources and tests on new technologies. The space station is also carrying equipment for monitoring the meteorite situation in the vicinity of Salyut-6, recording strikes by particles weight fractions of a milligram. The orbit of Salyut-6 is apogee: 365 km, perigee: 335 km, period of revolution: 91.4 minutes and inclination: 51.6°.

Spacelab Candidates Chosen

On the 22nd of December 1977 the European Space Agency (ESA) announced its candidates for the first Spacelab mission, now scheduled for December 1980. The four candiates are:

1) Franco Malerba (age 31) -- an Italian engineer working in the computer field;

2) Ulf Merbold (age 36) -- a German research worker at Max-Planck Institute for Metallforschung;

3) Claude Nicollier (age 33) -- Swiss researcher and pilot working at ESA's ESTEC;

4) Wubbo Ockels (age 31) -- Dutch physicist at Gronigen University.

The four candidates chosen had to meet the Level II criteria used by NASA to select permanent mission specialists. Eight other potential candidates were rejected on medical grounds, though ESA's Director General, Roy Gibson, said that the selection procedure should not be allowed to obscure the very high quality of European candidates.

On the first Spacelab mission about 70 experiments will be carried out in the fields of stratospheric and upper atmospheric physics, materials processing, space plasma physics, biology, medicine, astronomy, solar physics, earth observations, thermodynamics and lubrication.

SALYUT-6 STRIDES ON

by Phill Parker

The launch of the unpiloted ferry vehicle "Progress 1" by the Soviet Union on the 20th of January, 1978, to automatically rendezvous and dock with the Salyut-6 space station was another step forward towards the creation of a permanent inhabited platform in space.

It appears that "Progress 1," which was launched by a standard Soyuz launch vehicle, was a highly modified Soyuz spacecraft containing food supplies and other technical equipment. It appears, therefore, that the two cosmonauts aboard Salyut-6 are settling in for a long duration flight that may exceed the record 84 days in space set by America's Skylab-4 flight astronauts.

According to Soviet sources, the Salyut-6 space station with two Soyuz-type spacecraft docked is over 30 meters long, weighs 32 tons and has a habitable volume of 100 cu. meters. It is interesting to note that this matches the sizing developed in paper studies for NASA of the so-called Manned Orbital Facility (MOF) by several aerospace companies in America. The MOF, which would have taken its first flight in 1985 (seven years after this Soviet success!) would have featured several modular style units. There would have been four units termed the Habitable Module (HM), the Service Module (SM), the Logistics Module (LOGM) and the Payload Module (PM). Each unit would have fitted in the cargo bay of the Shuttle Orbiter. The overall docked length of the LOGM/SM/HM/PM would have been 30.7 meters and had a habitable volume of about 115 cu. meters in the combined SM/HM. The space complex would have supported up to four crew members rotated at 90 day intervals. The cost for the combined SM/HM alone would have been $157 million for R&D and some $197 million for production costs. The LOGM (ferry vehicle) would have been $38 million for R&D and $29.3 million for production costs. I think the comparison of the MOF against the achieved Salyut-6/Soyuz-26/Soyuz-27/Progress-1 mission gives an indication of the magnitude of the achievement in capability of the USSR. Admittedly, the Salyut-6 and ferry vehicles (bar descent modules) seem irrecoverable (unlike the Shuttle/MOF scheme) but, of course, if the Soviet Union develops a space shuttle -- well, anything could happen!

During the joint USA/USSR Apollo-Soyuz flight in 1975, the Soviet Union released some details about their Soyuz spacecraft and launch vehicle. Although the present Soyuz spacecraft and the Progress-l vehicles may differ in specialized areas it was interesting to note that the automatic docking mode for a Soyuz was quoted as from an approach rate of 0.05 to 0.3 metres/second with longitudinal axes displacement up to 0.3 meters. A misalignment of 7° was allowed for pitch, roll and yaw and angular velocities of l°/second (active role of docking craft) and 0.l°/second for a passive craft. I would suggest that similar values have been engaged for the Progress-l spacecraft. Precise tracking of the Salyut-6 spacecraft and guidance trajectory updates to Progress-l would have required accurate tracking by ground stations and, no doubt, tracking stations at major Soviet stations (like Djusali, Evpatoria, Ulhan-Ude, Kolpashevo and Tbsilisi, as well as ocean going tracking ships) would have been used. The use of the major Soviet control centre at Yevpatoria indicates a major stride forward in the computing capability of the USSR for space missions. (Not many years ago, they used orreries and charts and maps, longhand style!)

It appears, therefore, that Salyut-6 is a real, major step forward for astronautics and brings the dream of permanent habitats in space that much closer. The techniques of automatic ferry, rendezvous and docking, accurate tracking of multiple objects, and hosts of other items that will be needed for space manufacturing facilities will be much nearer due to Salyut-6.

The Cosmos-929 Enigma

by James E. Oberg

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Looking for puzzles in the mysterious Soviet space program? Well, you’ve come to the right place.

How about the spectacular Salyut-6 mission? Outside of the series of firsts in space -- double dockings, duration records, new spacesuits, orbital refuelling, water recycling, etc. -- the Salyut-6 is a respectable but not really very baffling event.

How about the Cosmos-954 debacle? True, the top secret nuclear-powered ocean spy satellite did fall out of orbit following a malfunction the Russians hoped the world wouldn’t notice, but here, too, much of the mystery has evaporated. A Soviet propaganda campaign has attempted to distract attention from the satellite’s top secret mission (spotting US missile submarines in preparation for a Soviet nuclear surprise attack, many experts postulate) and from the critical point that the Soviets tried to keep the nuclear nature of the vehicle secret, and from all similar ‘anti-Soviet hysteria’ (Pravda’s term, not mine). But it turns out to have been a good exercise in space law and space object recovery/analysis.

Nor was the Cosmos-955 radar eavesdrop satellite much of a puzzle either. Launched from the supersecret Pletsetsk space center north of Moscow, last September the midnight high lob trajectory resulted in a flurry of “jellyfish UFO” news reports from western Russia before Moscow realized that a security leak of giant proportions had occurred, clamped down, issued a bald cover story (‘reentering satellite’), and hustled the unfortunate cub reporter from Petrozavodsk somewhere way way east (and north) of Suez (would you believe Yakutsk?).

No, the mystery in space last year and early this year was Cosmos-929. On February 2 it dived back into the atmosphere after a baffling two hundred day excursion that left Western observers scratching their heads, consulting their computers, and speculating wildly.

What was Cosmos-929? What was it doing? And, most significantly, what was it a precursor practice mission for???

Cosmos-929 was launched last July 17 from the Tyuratam-Baikonur space center in Kazakhstan. A standard Soviet cover story was issued, claiming it was another scientific satellite aimed at the peaceful exploration of outer space for science and the national economy, a canned announcement usually reserved for military spy satellites, failed interplanetary probes, or advanced systems tests. Within hours, Western observers knew it was something special. Radio signals were similar to Soyuz and Salyut piloted (or unpiloted test) vehicles; the orbit had an inclination and altitude consistent with piloted space hardware; and within a few days, visual observations suggested that the object was of a large size, Salyut class or larger, twenty tons.

“We ran out of guesses,” complained one veteran amateur space watcher later. “First we thought it was a new model Soyuz test. Then it could have been a secret automatic Salyut, or a broken Salyut, or a component of a multi-modular Salyut. Desperately, we toyed with a stuck interplanetary or lunar probe, and even considered some new weapon system. But in the end we were driven to one conclusion: it was ‘none of the above”‘.

Cosmos-929 provided a series of subtle clues. A month after launching, one major telemetry stream ceased permanently and the other changed subtly, still indicating a twinned or dual nature of its radio system. Major orbital changes began, raising the altitude once at T+30 days and then again in December, five months into the mission. Then on February 1 the Cosmos, still hooting away on its constant radio channel, actually lowered its orbit from a circular one 450 km up to an elliptical path dropping to within 320 km of the earth (that was the altitude of Salyut-6, but the two vehicles did not seem to be related since they were 75 degrees out of plane). The following day, Cosmos-929 committed space suicide by firing its propulsion system yet again and plunging to its fiery destruction above the Pacific.

Over the two hundred days of operation, it had used more than nine hundred feet per second of velocity change. “It’s a flying gas tank!” marveled a space radio listener in Fort Worth.

Other hints were found in the Soviet press. Two years before, a top Soviet space designer had discussed Soviet plans for the assembly of space stations from Salyut-sized components launched separately (the maximum Soviet space payload weighs little over forty thousand pounds). Rather than launch each section with its own rocket, power, and rendezvous/docking control system, the scientist described how a ‘space tugboat’ or KOSMO-BUKSIR would be used. It would stay in orbit for months, seeking out each component as launched, and docking with it. Then it would push the component over to the assembly orbit and would gently dock it’ to the structure, before pulling away to await the next launch.

Could the Cosmos-929 be a space test of this KOSMO-BUKSIR, ‘space tugboat’? Considering-its lifetime and velocity change capabilities (and the recent refuelling operation of Progress-l, which could work just as well for a ‘space tug’), it seems the last choice open . . . and a not unlikely one. Perhaps, too, it was connected with an equally mysterious Soviet space shot in December 1976. According to Moscow, two satellites called Cosmos-881 and Cosmos-882 were launched by the same rocket and completed their missions before the end of the first orbit. Observers were mystified.

The prestigious “TRW SPACELOG” annual satellite review reported that Cosmos-881/882 was launched by a ‘Proton’ rocket, Russia’s biggest, and presumably the same type which seven months later launched Cosmos-929. The dual nature of Cosmos-929 radio signals, which was illustrated by its switching from one telemetry system to another almost identical one every thirty minutes, might be connected with the actual double satellite hardware of the earlier launch. But many questions remain.

If indeed these two shots involved the space tryouts of new Soviet human-related hardware, it will be the first new class of vehicle in more than seven years. Past practice has been to flight test a vehicle from 18 to 36 months prior to its actual piloted utilization, which would put the operational assembly of a two or three module ‘super-Salyut’ eight-person space habitat in the 1979 time frame, contemporarily with the Space Shuttle.

So the mysteries of Russia’s space program remain, and even grow deeper. One fact is not obscure, however. The space hardware now on hand, and in various stages of flight testing (whatever Cosmos-881/882 and Cosmos-929 really are), demonstrate the Soviet Union’s high level commitment to permanent habitation of near-Earth space in the immediate future. Scheduling themselves around their occasional endurable setbacks, the Soviets are moving ahead with all the hardware needed for space stations.

There will be Russians in space not just today and tomorrow, but from now on. Forever. The commitment and the hardware are there.

Military Pilot Astronauts Defended

by Jim Oberg

I'd like to make some comments about the issues raised by Robin Snelson regarding selection of NASA pilot astronauts. The fifteen men picked last January seemed to confirm her worst fears: all but one military pilots, and the one exception an ex-Navy pilot who works for NASA. What about commercial airline pilots? What about people in non-military programs, such as Angela Masson (3500 hours flying, PhD -- apparently in some branch of sociology or political science, I should add).

I want to argue that the selection criteria are valid. It's hard to tell people that they are not what is needed, when they have wanted to be astronauts for all their adult lives. That's tough. They guessed wrong ten years ago. The key is not 'military' duty, since commercial pilots probably have the same discipline and commitment. The 'test pilot' requirement is justified, as well as another NOT mentioned by Snelson: the jet experience should be in high-performance jets, fighter aircraft. Why? Because the Space Shuttle is a 'hot' vehicle that flies like a clipped wing F-104, not like a 727. Let me point out that no military transport pilots were selected -- that is an important point not realized by Snelson. It is a key point, too.

(The Soviets have chosen transport pilots among their cosmonauts, but the Soyuz does not fly like an airplane of any sort -- and I hate to have to say it, but the two transport pilots who did fly, Sarafanov and Zudov, just happened to be on missions where the rendezvous/docking maneuvers were unsuccessful. I hasten to add that it happened to other pilots too, and there is no indication of pilot error!)

The argument that the Space Shuttle pilot does not have to know how to fly such 'hot' aircraft because the spaceship can land automatically is a specious one: our whole space experience has shown that piloting capability and training makes all the difference between successful missions and failures, even tragedies. Hence the entirely reasonable desire to have men who have flown similarly behaving vehicles for many years. And how about test pilot work? This, too, is quite relevant. Few people realize just how closely astronauts work with design and planning groups in the reputation of the mission and of the hardware itself. The Space Shuttle is not routine and will not be for several years. People with experience testing and flying new aircraft, especially those in which there is a very real possibility that design errors and pre-flight oversights will mean death, are the kind needed. I do NOT believe that commercial pilots, however safe I feel putting my life in their hands on travel, have these qualifications. Again, sorry about that, you guys and girls. Seriously, maybe next time.

More on Military Shuttle Pilots

by George S. Quin, Jr.

After reading the article entitled "Astronaut Corps -- Or Space Soldiers?" in the January issue of L-5 News, I realized that several of the points raised need definite clarification.

Mr. Good is obviously unaware that the Space Shuttle Program *is* an international effort. Spacelab, being constructed under the auspices the European Space Agency (ESA), by several Western European corporations is an integral part. of the Space Shuttle Program. By agreement with NASA, ESA personnel will also be included as mission specialists and astronaut scientists in several projected missions. Nor has the number of active duty military astronauts affected NASA's excellent relations with the Soviet, Canadian, Japanese, or other national space agencies.

As for public reaction to military astronauts -- when has a significant public sector protested their backgrounds? Instead, one can't help noticing the number of "ticker tape parade" type ceremonies honoring them and the spectator packed luncheon/dinners enthusiastically applauding these men at the conclusion of their popular talks. In short, our society has idolized these men as "all-American" -- what few boys didn't say at one time or another that he was going to be an astronaut when he grew up? The public clearly accepts their military backgrounds as necessary and I'll show you why for pilots it is.

First, let's look at the background to Mr. Good's statistics. NASA is under federal mandate to be an equal opportunity employer and has made extensive efforts to recruit minorities and women. But the fact remains that few are initially qualified and even fewer can meet the necessary technical requirements even as a mission specialist. What is not mentioned is that of the twenty mission specialist candidates recently selected -- six are women, three are black, and one is Japanese-American. I strongly doubt that even the U.S. Supreme Court would consider itself competent to determine personnel ratios in the astronaut corps because of the technically explicit nature of the occupation.

NASA needs military test pilots. The terms "routine" and "space truck", that Mr. Good is mistakenly building his legal case on, are only PR imagery words. The Space Shuttle is a very complex space vehicle (not a diesel rig!) designed to operate in an extremely hostile environment (far from rescue) where mistakes are lethal. As for automatic systems and ground control, no machine can be 100% reliable. The Apollo 13 explosion and the Skylab repairs are typical of the importance of man's role in space. The Space Shuttle represents a multi-billion dollar investment -- the taxpayers and the flight crew deserve the best pilots available to protect human lives and tax dollars.

The military test pilot represents the cream of his pilot peers. His position comes only through self dedication, skill excellence, and their recognition by his superiors.

Since the Department of Defense is scheduled to be one of NASA's primary customers, its requirements for the Space Shuttle Program had to be met. Besides specifying that the payload bay be large enough to accommodate a "Salyut-size object", it also has stringent personnel security requirements that only active duty military astronauts can meet. Especially when the Shuttle crew will be handling the deployment of a high energy laser ABM system, military communication/reconnaisance satellite networks, and "defensive" hunter-killer satellites. In theory, military involvement in space will reach a critical point by the late 1980's and NASA may be right in the middle of it because of economics.

In 1981, the first women will graduate from our service academies with training and at an expense equal to their male classmates. Because of this, several Congressmen are already working on legislation to allow women to assume combat roles, notably that of fighter pilots. Eventually this may lead to an "optioning" of the military test pilot requirement or its removal altogether. But only time and public interest groups shall determine the future of the American space program and astronaut corps.

Inside the L-5 Society

Annual Elections on Horizon

The L-5 annual election for the Board of Directors is coming up in June. If you would like to nominate someone for the Board, send your choice to: Nominating Committee, L-5 Society, 1620 N. Park, Tucson, AZ 85719. Please send a resume and/or a brief writeup on why your candidate should receive approval by the nominating committee. Be sure to get your candidate's permission to be placed in the election -- most folks look askance on being run for office without their acquiescence!

Who are the nominating committee? At least three must not be current members of the Board. If you would like to serve on that committee, write in to the Board at the Tucson L-5 address immediately, if not sooner. The Board selects the nominating committee members.

What if your candidate is turned down by that committee? In the past, reasons for disapproval have focused on lack of qualification and excessive controversiality. Their position has been that the burden lies upon the candidate to show that he or she will benefit the Society as a Director. However, if rejected candidates insist or running, it has been past policy to offer the membership list to them so they can make their own appeal.

What does the Board do? All authority is held by it. Note in the bylaws that the L-5 President has no duties or powers except as assigned by the Board. The Board elects the President (currently Carolyn Henson), Secretary (Carol Motts) and Treasurer (Bill Weigle); authorizes expenditures, sets policy guidelines, determines who can be official spokespeople for the Society, and conducts the elections.

What powers do the members have? First, all Board members must receive a majority of the votes cast in the election. Second, any bylaw change requires approval by 2/3 of the members voting.

The Board is working on some proposed bylaw changes. If you would like a copy of the bylaws write in and we will send you one! In the June issue we will publish the complete bylaws and proposed changes. Do you want to propose changes?

Please note: at the request of some Tucson L-5 members a meeting was held last October to consider bylaw changes. However, no one showed at the meeting! Apathy' may run rampant at times, but bylaws are important.

L-5 WE Conference on Space Settlements & Space Industries -- A Note About the Proceedings

The L-5 Society (West European Branch) had hoped to publish the full Proceedings of the Conference on Space Settlements and Space Industries that was held on the 20th of September, 1977 at Queen Mary College, London. However, the financial cost of typing, duplicating and distributing the full Proceedings of this Conference, unfortunately, outstrips the available funds in the Branch account. Various quotes for typing the estimated 100 pages plus of text would have been from about £300 up to nearly £1,500!!

In view of this, the plans for publishing the full text have been abandoned at this time. However, a new plan is in operation to publish an Abstracts Report that features highlights from each paper (together with some commentary to place readers in the 'picture' about each paper) and containing the text of the Keynote Address (by Mr. John Disher, NASA) and some detailed reference sources for further data. This latter section will feature names/addresses of the authors of the papers (for those people who would like to acquire the full science/technical texts for research utilization) and a reference to the L-5 Reports Service. It is hoped that a copy of each paper, in full, will be placed with the L-5 Society HQ where copies could be obtained for a reproduction cost. It is hoped that this new plan will satisfy the requirements of those people who eagerly await the proceedings of the first L-5 Society (WE Branch) Conference and trust that they will understand the economic constraints placed upon the branch.

The Branch Director, Phillip Parker, is undertaking the job of typing and reproducing the Abstracts Report and he states that this is well advanced and should be ready for publishing in February 1978 with distribution that same month. All inquiries on this matter should be addressed to him at his home address: Phillip J. Parker, AFBIS, Director, L-5 Society (WE), 40, Lamb Street, Kidsgrove, Stoke-on-Trent, ST7 4AL, England, UK.

Branch Director on Italian TV

The West European L-5 Society Branch Director, Phillip J. Parker, did a major television filmed interview for national Italian television (RAI -- Radiotelevisione Italiana) on the 10th of January, 1978. The filmed interview, produced in London by RAI's UK Correspondent, Sandro Paternostra, with a film crew lead by John Metcalfe, was relayed to RAI's Rome offices via the Eurovision network. The filmed interview, featuring details about the L-5 Society and space colonies, was to form a major part of a l-hour television documentary on spaceflight being broadcast by RAI, in Italy, on Saturday, 14th January 1978 under the series titled "All About Yourself". RAI's potential viewing audience was reported to be about 50 million, since the program was at the peak viewing time of 5:30 p.m.

The interview with Phill Parker centered around describing the wheel-shaped space colony (good use being made of Phill's space colony model!) and describing the space shuttle (again using to good effect a scale-model of the shuttle). Close-up shots were taken of the models and these were spliced together with close-up views of paintings of the NASA-produced studies of the space colony showing interior views of a colony, to give a very good overall concept of life in space c.2000.

Quebec L-5 News

Andre Fontaine recently gave a 30 minute television interview on space colonies for CJPM-TV in the Chicoutimi area (about 130 miles northeast of Quebec City). A second program on the subject will be aired shortly.

For more information, please contact J. Andre Fontaine G, 1185, Avenue Brown, #3, Quebec, QC, GIS 3Al.

Huntsville, Texas Chapter Formed

A branch of the L-5 Society has been formed in Huntsville, Texas at Sam Houston State University. They call themselves PIIOS (pronounced pi-ose) the Put It In Orbit Society. The president is George Bigham.

PIIOS has already formed liasons with the Austin, Texas and San Marcos, Texas Chapters. Current PIIOS projects include a presentation at the Quality of Life conference, where they will field speakers on SPS and L-5 colonies, an Earth resources exhibit loaned to them by NASA, as well as well as showing video tapes, films and slides.

For more information. please contact Tim Bigham, Rt. 2 Box' 82, Huntsville, TX 77340.

Ann Arbor Action

The Ann Arbor L-5 group has initiated a monthly newsletter, *The Missal*. It is available for $3.00/year from L-5 Society, Box 126 Michigan Union, Ann Arbor, MI 48109. The first issue carries articles on "Object Kowal" (a possible new planet) and hazards of exposure to vacuum (disarmingly titled "Outer Spaced") as well as news on space action in Congress and local Michigan L-S activities. *The Missal* is entertaining, informative, and carries items you won't catch if you restrict your reading to the L-5 News.

Maryland News

The Maryland Alliance for Space Colonization has initiated a bisemester publication, *Outlook*. It carries news, articles, bibliography and local events. Membership in MASC is $2 for students, $5 for regular members. Please send membership dues to: MASC, c/o Gary Barnhard, 4323 East-West Highway, Bethesda, MD 20014.

Williamsburg News

The followine activities are scheduled for the L-S Williamsburg, VA group:

April 3 -- "The Transition from Science Fiction to Reality," with guest speaker Frank Kelly Freas of Virginia Beach, the dean of science fiction illustrators, with a companion display of the artist's work, in Small 109 at 7:30.

April 21 -- "Social Factors in Space Humanization," an address by Stephen Cheston, associate dean of the graduate school at Georgetown University, in Small 109 at 7:30.

IMPACT!

On six consecutive Saturday afternoons -- March 18 and 25, April 1, 8, 15 and 22 -- the L-5 Society will sponsor discussions focusing on the prospective impact of space settlement in six general areas: Technology, Government and International Relations, Social Science, Commerce, Education. and Philosophy. In special cooperation with the Departments of Physics, Government, Sociology and Philosophy, and the Schools of Business and Education. Details to be announced. Contact L-5 Society, Box 1795, Williamsburg, VA 23185 for more details.

Previous Williamsburg L-5 activities have included talks on space colonies by Bill Bryant and Brian O'Leary, "Theatre of the Future: A Preview of Coming Attraction," premiere of a multimedia presentation of the evolutionary perspective featuring Barbara Marx Hubbard, co-founder of the Committee for the Future, and a lecture on the space shuttle by Lester B. Taylor.

News from Philadelphia

I am planning a unique promotional scheme to publicize our public lectures. It will involve as many L5ers around the Phila. Pa. area as possible. We can launch an ad campaign as large as the big corporations are capable of. By operating on a strictly voluntary basis, those who feel that they want to help can do so at minimal cost to themselves. By acting as a group we can dissipate the costs of this far reaching ad campaign.

We here in Phila. are planning a lecture, slide show and a movie "The Libra Colony" for:

Marple Township Pub. Library, Springfield and Sproul Rds., Broomall, Pa. 19008, April 1, 1978 at 2 p.m.

Phila. Pa. Central Library on the Parkway, Wed. May 3, 1978 at 7 p.m.

Frankford Y.W.C.A. 4606 Leiper St. Phila. Pa. 19124 Sat. June 3, 1978 at 1 p.m.

Please choose as many or all of these to advertise as you wish.

What we want L5 members to do is to start their own ad campaign for us on a local basis. Rack your brains and think of as many groups of people that you can reach. Ads in college newspapers, high school newspapers, trade journals, local or specialized magazines, community newspapers, town and city newspapers, posters on billboards in churches, libraries, schools, offices, Y.W.C.A.'s, Y.M.C.A.'s and public places. By each of us advertising according to our own expertise and spending as much as each of us can afford, we can reach a maximum number of people and we can hope for a good turnout.

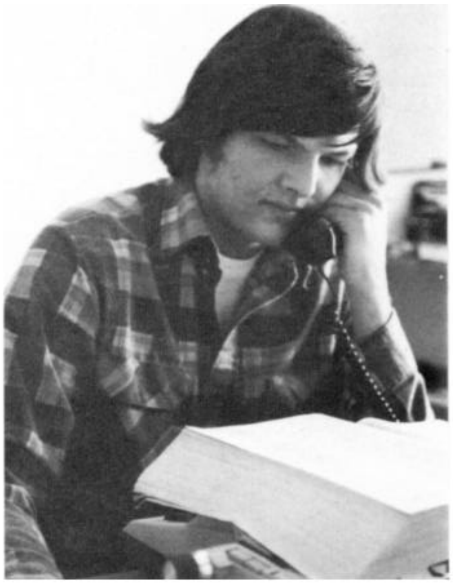
An ad in most newspapers costs less than three dollars. A hand made poster costs less than forty cents. Word of mouth costs nothing. Come and bring all your friends, lets make these shows an L5-IN. Our sheer numbers will impress those outsiders who attend. This will be your first chance to see the new Libra Colony movie at a public showing. Admission is free. -- Richard Bowers, president; Space Futures Society, 3059 Cedar St., Philadelphia, PA 19134, phone 739-7780.

Fellow L-5'ers. I just got through with reading the recently-published Space-Based Manufacturing From Nonterrestrial Materials. This is Volume 57 in the American Institute of Astronautics and Aeronautics series. As a member of the A.I.A.A., I can get this volume at a reduced price ($15 vs. $23 list). If anyone would like me to pick them up a copy (enclosed in the original plastic with invoice), send me a check for $15.00 plus a couple of bucks for postage depending on where you live [ask the post office]. My address is: Elliot R. Royce, 86 Rowayton Ave., Rowayton, Ct. 06853.

Lobby Vacuum

Do you want to lobby? The L-5 Society has a special fast news service covering space related political activities in the United States -- the Society won't tell you what to do -- but we'll give you the information necessary to make intelligent decisions and take effective action.

If you want to get wired into the L-5 hot line, send in your name, address, and if you are willing to accept a collect call in an emergency, your phone number. We also would appreciate a brief essay on your qualifications and ideas on how to take political action as well as a history of any previous political activities. Please let us know if we have permission to pass your name on to responsible space lobby groups.



Marc Boone on the "hot line."

The following states have no people receiving the L-5 Society space legislation hotline: Alabama, Arkansas. Delaware. Nebraska, New Hampshire. North Dakota, Tennessee, Utah, Vermont, Wyoming, and West Virginia.

It is vital that at least one person in each of these states take the responsibility to keep their Representatives informed of the status of SPS, space industrialization and utilization, and whatever bills are relevant to these subjects, even if only by writing letters. Often one letter from a constituent to an uncommitted Representative is enough to swing a vote. You may influence the course of history! To get on the hot line, write to Marc Boone, L-5 Society, 1620 N. Park Ave.. Tucson, AZ 85719).

Letters

Private Enterprise Boosters

One comment on December's issue. Lutz Kayser of OTRAG and Christian O. Basler have the right idea when it comes to space industrialization. With the world caught up in the energy crisis -- rich U.S. poor nation competition, most governments are unable to afford or unwilling to consider the possibility of energy from space, except as a long term alternative, safely booked beyond the year 2000. My suggestion to Christian Basler is to investigate what products could be competitively produced in space (as a first step) and by that I don't mean taking Ultra-Brite up on the shuttle, then advertising it as the toothpaste that flew in orbit. Once the staging company has a product line, capital could be secured to build the plant. A private enterprise approach is the only way space industrialization will happen within the next 20 years.

James Kempf
Tucson, AZ

I believe that space colonization is a perfect solution the world's biggest problem: government control over the lives of individuals such as taxes, victimless crime laws, and business regulatory bureaucracy. Once we colonize space, it will be impossible for a government to exercise control over the entire surface of a sphere with a radius of 93,000,000 miles, not to mention the asteroid belt. For the first time in history, we will have a true laisse faire market place where all trades are decided solely between the buyer and seller. Its only cost will be 8 billion dollars per year for twenty years to the American taxpayers. When it begins to turn a profit, each of the taxpayers can be given a share of stock in the company to make it into a private corporation, just as economist Milton Friedmann proposed to do with government corporations today.

Michael M. Doty
Houston, Texas

I have a suggestion for those who may be thinking in terms of a non-governmental space industry/colony. Policy should be that, provided the applicants were qualified, job preference would go to stockholders on the basis of number of shares owned and length of time held. If we have to dig into our own pockets to finance the chance to go into space, this policy would only be fair. Besides that, a lot of stockholders on the scene might keep down cost (after all, it's your dividend). Some of the most successful companies, such as Sears, are largely employee owned. We needn't worry about only rich people going into space, because there aren't that many millionare welders (or gardeners, or cooks). One NASA official held (at the '75 SMF conference) that space workers would be hard to find. He was taken to task by a future L-S member who thought the problem would be prospective workers bribing the selection committee. Bribe early, buy a share of the FAR OUT Company.

H.T. Watcher
Tucson, AZ

Lobby Comments

Being a Texan, I am "frontier oriented." Having been involved in large realty projects with their energy systems, capital costs, and expenses, I know firsthand of the certain-future industrial breakdown if new, environmentally acceptable, permanent energy resources are not found. Having oil & gas properties, I knew firsthand about "depletion." Nothing is so graphic as having monthly checks decline, then stop coming (sorry, all gone). So, the SPS alone has immediate and great appeal. But further, I'm sold that SPACE IS THE NEW ECONOMIC FRONTIER. We (the U.S., the West in particular) must develop as quickly as possible the capability for working, living and operating in this vast, new, enormously rich environment.

Politically, to get it done we in L-S must stress heavily the economic and resources potential of space. Personally, I fully support the "human adventure" aspect. But the nation is not about to fund a costly "subdivisions in space" adventure for a select group of fairly well skilled and educated adventurers -- not in an era when capital formation is certain to be our greatest economic problem. We must emphasize that space is the new ECONOMIC frontier for energy and resources, and that the nation can ill afford NOT to do it. We must develop the capability to exploit this new frontier as an essential condition of underwriting our common, universal future and preservation of Western democratic civilizations.

Sam Dunnam
Austin, TX

I commend the L-5 News for the several excellent articles in the last few issues which discussed lobbying, and would like to make two additional comments. First, as a non-profit corporation, the L-5 Society is prohibited from. substantial efforts "attempting to influence legislation". Therefore, when contacting Congressional or other legislative personnel, we should represent ourselves as individuals, not as L-S Society members. I suspect that this is more effective as well as more appropriate.

Second, a concise list of your Congresspeople is available from most Federal Information Centers, which are listed in the phone book under U.S. Government. By calling and asking for a copy, you'll receive a mimeographed mailing and avoid having to get the information on the phone. Be sure to ask what district you live in if you don't know; the lists cover fairly large areas and thus may have more than one Representative. The lists appear to be available from many Federal Information Centers; they apparently get this question often enough to justify mailing it out.

As an L-5 Society member, I encourage the *L-5 News* to continue their excellent coverage of events surrounding space-related decisions in government. As an individual, I urge all readers to lobby the hell out of their Congresspeople!

Strive for L-5
Jay Vivian
Boston, MA

They're killing the goose that laid the golden eggs. That was my first impression at seeing details of the $4.371-billion NASA budget request for Fiscal 1979. The 8% increase in NASA funding over Fiscal 1978 has been eaten up by an 8% inflation rate, leaving the Space Agency with no overall growth in capability.

Among other things, NASA is limited to the same number of employees it already has. The Office of Management and Budget (OMB) has reduced funds available for earth resources and communications supporting R & D. The Carter Administration has cut advance planning funds for space transportation systems, large space structures, and advanced manned flight systems. According to Aviation Week & Space Technology (Jan. 30, 1978), "NASA officials believe the Administration. is concerned that too active advance planning in these areas could lead to future requests for larger programs in space such as manned platforms or even a U.S. space station." Read that last sentence over a few times and grok its implications. . .

Gone from FY'79 are the Lunar Polar Orbiter, Mars 1984 Viking Rover, Halley's Comet Rendezvous/fly-by, and funding for the fifth Space Shuttle Orbiter. Orbiter 101, the "Enterprise," will remain a "hangar queen."

There will be several new space craft starts in Fiscal 1979, including the NASA/ESA Solar-polar out-of-ecliptic missions. There is a sizeable increase in the Office of Aeronautics and Space Technology research and technology base; however, many of the increases in NASA's FY'79 budget are the results of funding peaks in on-going programs such as the Space Shuttle, Large Space Telescope, and Jupiter Orbiter Probe.

The Carter Space budget request is the action that speaks louder than words. It is barely adequate to support on-going programs and is dangerously lacking in long-range goals. NASA FY'79, as proposed by the Carter Administration, is a prime example of "penny-wise, pound-foolish," and should be increased if at all possible (Hint: the President proposes; Congress disposes. Have you told your elected representatives what you think yet?).

The FY'79 Space Program proposed by Carter represents less than 1% of his record-breaking budget of 500 billion dollars, a drop in the Federal bucket. Those of us who want to see an expanded Space Program had better start doing something about it. If we don't, who will?

Robert G. Lovell, Jr.
Shawnee, Kansas

In the Letters column of November, Robert Lovell suggested that the budget-cutting "enemies of space" would be out to "get" NASA. I don't think that'll happen. Any member of Congress knows that losing on controversial issues is something that happens all the time; you take your defeats gracefully and try again next time. NASA has its share of critics, but there are few if any in Congress who are so strongly opposed to its mission that they would be called "enemies". True, Sen. Proxmire is one if anyone is. But he's just one Senator. And even though he chairs the committee with oversight responsibility for NASA's budget, there are enough friends of NASA on that committee to prevail. He's headed that committee for several years now, and has had more bark than bite.

The December issue also carried a description of forthcoming SPS research, noting that it will receive $19.5 million over the next four years, "compared with fusion research at $400 million next year". Those of us who are old fusion hands will read that with amusement. Fusion was first funded in the early 1950's. By the late 1950's it was at about $30 million per year -- and there it stayed, for some fifteen years. I recall a 1971 review in Scientific American, in which the author stated that fusion was to get only $38 million, and wistfully hoped that more would come.

The difference is that late in 1971, fusion proponents had become sufficiently secure in their understanding that they were able to go and request more -- which they soon got. So this fact, that fusion funding increased tenfold in a few years, should give SPS proponents hope. Do not despair. Your time will come.

T.A. Heppenheimer
Heidelberg, West Germany

A note or two on the contents of the Dec. issue of L-5 News. First of all, I think that the remaining Shuttle Orbiters ought to be named for the cosmonauts and astronauts that been killed to date in operations. The Kamarov, and perhaps the Grissom. Or perhaps, to take a different tack, the Goddard and the Von Braun. The Oberth, so on.

Secondly, I find the labeling of Senator Proxmire as 'Darth' appalling. This is the same thing, if you will recall, that the Nixon administration fell into, and that caused its excesses of power: the identification of a differing political view as the posture of an enemy rather than an adversary. Senator Proxmire is a man to be opposed, but not 'fought.' He is not the enemy, but he is most certainly the opposition. One can be opposed to something and not be an evil person; perhaps merely a misguided and short-sighted person, but not evil per se! If we, as space enthusiasts, expect to operate successfully in the political arena (as we must if we expect to obtain a more expanded space program) it behooves us to do so with some manners and a modicum of decorum.

Tim Kyger
Dayton, OH

Let's get someone clearly on the other side of the political spectrum to become a board member too! (Jerry Brown?) If the public associates our goals only with people like Goldwater & Heinlein we may be cutting our own throats. We must stress that benefits from space help everyone, and that ordinary terrestrial political affiliations do not define. the ideological scope of the utilization of space.

Jon Coopersmith
Point Pleasant, PA

Space Colonies Make Strange Bedfellows?

In general I find the L-5 News great. But please forgive me the statement that I always felt uncomfortable whenever Timothy Leary appeared on the pages, and just 10 minutes ago I first was shocked and then got mad at the nonsense T. Leary is writing in "The Psychological Effects of High Orbital Migration" (L-5 News, Sept. 1977, pg. 18). I have lived in the U.S. for two years and in South America for three years, and know from my own personal experience that T. Leary's arrogant characterization of the South American individual and social character is quite wrong. There are people who would even name quite a number of reasons why one should exchange several characterizations between 1 and 2.

Please do not put Gerry O'Neill in company with Timothy Leary. O'Neill and space colonization deserve better.

Prof. R. Kummel
Universitat Wurzburg
West Germany

A quick scan through the letters section in this and past issues shows that the L-5 News *often has carried articles that members have disagreed with. If we were to restrict the contents of the* L-5 News *to items on which everyone is sure to agree. it would be far shorter, and certainly less interesting -- CH.*

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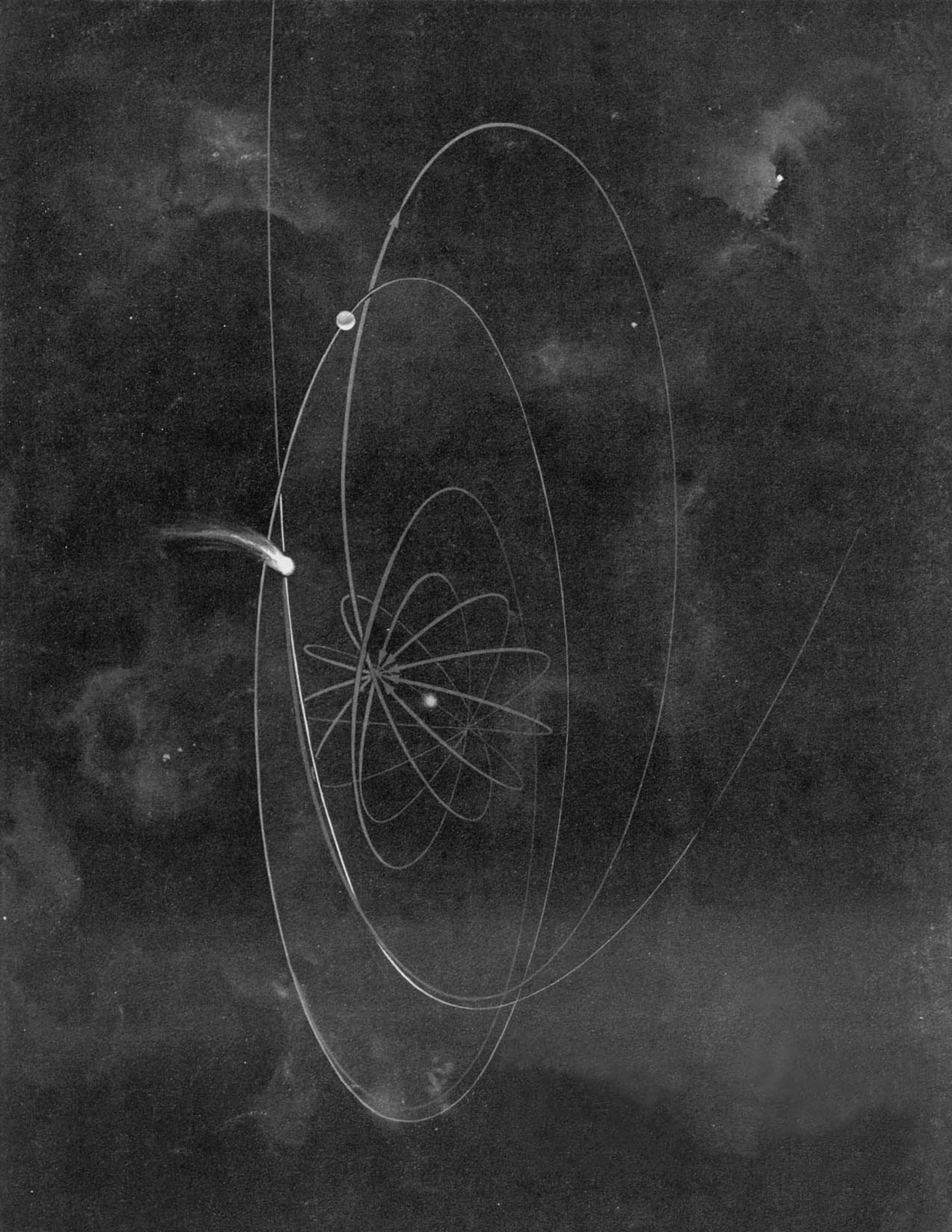

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In this issue:

1 **Sunsat Energy Council Formed**

2 **Jimmy C. Will Increase NASA's Budget If Good Friend Jerry B. Will Take Permanent Space Walk.**

High Frontier Bill Introduced

3 **Convair to Design System For Space Orbit Assembly**

UN Committee Discusses Space Issues

Tethered Satellite to be Studied

Art Form for Space?

4 **Shuttle Update**

5 **So You Want to be an Astronaut?**

Astronaut Candidates Selected

6 **Be Your Own Astronaut** *Space entrepreneur Paul Siegler reports on a daring plan by Robert Truax to lob people into space.*

7 **Space Mines, Space Law, and the Third World** *by Eric Drexler*

8 **Russia's Bios-3 Mini-Colony** *by Phill Parker*

9 **Compliments and Caveats** *T.A. Heppenheimer comments on the Salut-6 space station.*

Salyut-6 Facts & Figures *by James E. Oberg*

12 **OTRAG News**

14 **Bibliography Update**

16 **Conferences**

17 **Inside the L-5 Society**

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Front Cover: Interior view of a Bernal Sphere space colony one mile in diameter housing ten thousand people. A detail of this picture is shown in **The High Frontier,** by G.K. O'Neill, paperback, Bantam Books, 1978. *(Art work courtesy Don Davis.)*

Sunsat Energy Council Formed

Peter Glaser, shown standing, at the first organizational meeting of the Sunsat Energy Council Dec. 7, 1977. Glaser, founder of the Council, is the originator of the solar power satellite concept and a Vice President of Arthur D. Little, Inc.

Representatives of 42 major American energy and aerospace companies joined in Washington, D.C. April 6 to announce formation of the "Sunsat Energy Council," a group promoting production of electric power from solar energy as a long term solution to U.S. energy problems.

According to the council, electricity would be produced from sunlight by large power plants orbiting in space. This electricity would be sent back to earth for use in homes and factories. Each of the satellite designs now under study by NASA could supply enough electricity to run a city the size of New York. "Solar electric power would be clean and inexpensive," says Art Dula, aerospace lawyer and Sunsat member, "both industry and government studies show that by generating electricity in space, where sunlight is strong and continuous, enough energy could be provided to reduce U.S. dependence on imported oil and allow continued economic growth."

Studies by Boeing and Arthur D. Little suggest that the first commercial satellite could be in operation as early as 1995.

Jimmy C. Will Increase NASA's Budget If Good Friend Jerry B. Will Take Permanent Space Walk

©1977 **New Times** magazine

Jimmy Carter, who as late as the last presidential election was known as a master' of political symbolism, has not escaped the cosmical message of the man with an even more perfect grasp -- the 39-year-old perfect master of political symbolism, Jerry Brown. Brown's most recent display came in his flashy support for American space initiatives -- support which could cause a skittish President to cripple the federal program.

"There seems to be a back-lash from the White House whenever Brown talks about space," a senior staff scientist at NASA headquarters in Washington told us. "Every time Jerry Brown says something about space, the OMB (Office of Management and Budget) comes after our budget," another high NASA official said.

NASA contractors reportedly have been "encouraged" to steer clear of Brown. on pain of thinner contracts.

Brown's fabulously ambitious California dreaming goes far beyond little things like the White House: Last August, Brown and his state hosted a convocation of aerospace executives, NASA officials and media and space supporters for something called Space Day. Rockwell International -- central contractor for the space shuttle -- paid for the celebration. Introducing his cabinet, Brown chilled White House spines with his unveiled ecotopian threat: "We have plenty of money for space. In fact, I'd like to point out that our state surplus is just slightly smaller than the entire NASA budget. I'm not offering it . . . (laughter) but I do set it as a yardstick of what's possible."

Astronaut Jack Swigert (Apollo 13) recently announced his candidacy as Republican nominee for the Senate seat held by the Democrat incumbent in Colorado. He joins Astronauts John Glenn and Harrison Schmidt in turning to politics as a career choice.

Dear President Carter:

I respectfully urge maximum feasible funding of the nation's space program.

Space is the energy and resources frontier of the future--the only genuine frontier we have left. Sharp cutbacks in NASA's budget now, just as we are discovering the unexpected, practical payoffs of the space program under presidents Kennedy and Johnson would be to let go fallow the enormous capital investment the nation has already made in space and to delay momentous developments in energy, resources, communications, and environmental management systems which are now within our technological grasp and capability.

I received a copy of Majority Leader Jim Wright's letter to you of 29 March 1977, and also of Bert Lance's reply to Mr. Wright's of 16 June 1977. I fully support Jim Wright's pleading for the Solar Power Satellite project, and was extremely disappointed by the tenor of Mr. Lance's reply. I have the sense we are "stalling out" just at the time we should be making a maximum effort in this vital area.

As a Democrat, a businessman, and one of your strongest supporters, I plead with you to reconsider and not shortchange the needs of the U.S. Space Program.

Respectfully yours,
Sam E. Dunnam
Austin, TX

High Frontier Bill Introduced

Senator Harrison A. Williams, Jr. (D-NJ) has introduced a bill which calls for a 2 year, $1 million study on solar power satellites by the National Science Foundation. "The two-year investigation I propose," Williams said, "would be the necessary first step, and a decision whether to proceed could be made by 1980. . . If Dr. O'Neill and his colleagues are correct, solar satellite power generation, at the very least, would supply cheap energy for half the world's electricity needs, without the need for major technological breakthroughs."

The legislation would provide for an analysis of the benefits, costs, and impacts of implementing the "High Frontier" program in relation to jobs, environment, international relations, and national security. Williams asked that $l,000,000 be authorized for fiscal years 1979 and 1980 to the National Science Foundation which would make recommendations to Congress and the President, based on data obtained during the study to determine whether the program should be adopted as a national goal, as was the moon program in 1961.

"Congress has been inundated with energy legislation to correct the immediate and short-term supply problems," Williams said, "but it is necessary to consider long-range solutions and alternatives for future generations as well. The High Frontier program could offer such an energy alternative, and I hope that action will be taken quickly on this legislation." The bill will fall under the jurisdiction of the Senate Committee on Human Resources, which Williams chairs.

Convair to Design System For Space Orbit Assembly

General Dynamics has received a contract from the U.S. Air Force to provide a conceptual design of a large space system that could be assembled in orbit using the Space Shuttle Orbiter.

Convair division was awarded the $750,000 contract by the Air Force’s Space and Missile Systems Organization (SAMSO) who also awarded a competing parallel contract to Martin Marietta Aerospace. The basic task will be to develop a conceptual design of a spacecraft that will be assembled in space from large deployable modules. The assembled modules will result in a final spacecraft that is between 600 and 1,000 feet in diameter.

According to Russ Thomas, Program Manager, Convair will also design a prototype spacecraft to demonstrate the deployment and on-orbit assembly technologies using a single Shuttle flight. “We see this design as being a total space system; a spacecraft with an upper stage, avionics and guidance package,” he said.

Mr. Thomas regards the new Air Force contract as a significant addition to the company’s Advanced Space Programs and one which complements existing National Aeronautics and Space Administration programs.

“Our initial effort,” he said, “will define an operational spacecraft system. We ‘will then define the flight demonstration model.”

Subsequent phases of the project involve ground validation, including simulation of techniques for rendezvous, alignment and final docking.

The hexagon-shaped modules are envisioned as large as 400 feet across. Three or more of the modules linked together would form the spacecraft antenna system which would be used for general communications or as a space-based radar. Thomas said that each packaged module would first be carried into a 180-mile low earth orbit in the Orbiter’s cargo bay. After deployment from the Orbiter and erection, a transfer stage would then boost the system into a 22,000-mile-high earth synchronous orbit, where it would dock with previously deployed elements.

According to SAMSO, the prototype demonstration model could provide a platform to perform tasks unique to the space environment, such as servicing, rendezvous and docking as well as testing. Plans call for automated assembly in space with manned supervision.

The flight demonstration article will be used to verify the Shuttle’s capability to deploy future Department of Defense spacecraft that might require assembly in orbit.

Thomas said the on-orbit assembly could mature into an operational system in 1986 with continuing missions at least 10 years beyond that.

U.N. Committee Discusses Space Issues

New York -- The 15th annual meeting of the Scientific and Technical Subcommittee of the U.N. Outer Space Committee concluded on March 2. The Subcommittee spent much of its time discussing questions raised by Cosmos 954, the nuclear-powered Soviet radar ocean reconnaissance satellite that disintegrated over Canada in January. The full Outer Space Committee may decide to set up a study to look into possible regulations or safety standards for nuclear power sources in space.

On remote sensing, the Soviet Union proposed a cutoff at 50 meters resolution on the dissemination of data. Other delegations expressed doubt about the utility of resolution as a criterion to justify control of dissemination, but most did feel that control of some kind would be appropriate for information about natural resources. Some third world countries supported the idea of creating a panel of experts to coordinate the activities of states and organizations in the remote sensing field. The Subcommittee alsodiscussed the monitoring of pollution by remote sensing.

Certain equatorial countries insisted that the question of sovereignty over geosynchronous orbit be referred to the full Outer Space Committee, despite the U.S. position that there is no scientific or technical basis for any claim of extension of national sovereignty to portions of geosynchronous orbit.

Looking toward the future, the Subcommittee set the stage for a final decision in 1979 on a world conference on outer space. At the initiative of the USSR, the Subcommittee also recommended that it add one new item to its agenda for 1979: questions relating to space transportation systems.

TETHERED SATELLITES TO BE STUDIED

by Phill Parker

Two companies, Martin Marietta and Ball Brothers, have been selected by NASA to look into tethered satellites. Such a satellite, attached to an orbiting Space Shuttle by a cable up to 62 miles long, has several potential applications. The primary application would be to gain scientific data from the Earth’s upper atmosphere in order to map the Earth’s magnetic and gravity fields and to assist in the studies of atmospheric or plasma physics. Other potential applications are: cargo transfer between space vehicles; retrieval of satellites or debris without having to maneuver the Shuttle; and transfer of large amounts of energy to a remote experiment or from a remote, possibly dangerous, power source to a space station.

ART FORM FOR SPACE?

A Canadian art workshop, Resolute Art Works of Toronto, announced plans for a possible orbiting artform, on the 27th November 1977. This group initiated a project to place a work of art into a 1½ hour orbit.

In describing the project, Resolute Art Works announced that they were approaching NASA on the feasability of a 1980 space shuttle launch for this sculpture. The work would be a series of nine silvery spheres, each of 300 feet diameter, placed in orbit 100 feet apart giving a total length of 3500 feet. The spheres would be made of segmented sections of thin plastic membranes with specially prepared reflective surfaces for maximum visibility. The spheres would have a skin thickness of 0.004 inches and be made of aluminised mylar. The total surface area of each sphere would be about 6½ acres. The spheres will be gas-inflated, using sublimating powder, in orbit. Each sphere will be packaged into a launching cannister, this splitting into two halves on reaching orbit, ‘when the gas inflation takes place. The orbital height being suggested is for this art work is apogee -- 290 miles, perigee -- 250 miles and inclination 49 degrees, revolution period 96 minutes.

Describing the work, the Resolute Art Works say that what makes this a ‘work of art’ would be the tension in it between the natural and the artificial. It makes its appearance in the natural sky, neither dominating it or being dominated by the sky. It bears a resemblance to stars but the resemblance is superficial since nine stars of equal size do not occur together in a straight line spaced equally apart nor traverse the sky every 96 minutes. They reason that the orbiting art work is an experiment in monumental building and that it is conceived as a monument appropriate to the Twentieth Century.

Shuttle Update

Next fall, more than three years since the last Saturn roared skyward from launch complex 39, the characteristic hustle and bustle of piloted space flight once again will dominate the scene at the Kennedy Space Center.

It will begin next October when orbiter 102, fresh from the assembly line in California, soars piggybark into KSC atop its 747 carrier aircraft. The stubby delta-winged craft-designed to rumble into orbit like a rocket. maneuver beyond the atmosphere like a spareship and return to earth and land on a runway like an airplane-will be the first of its kind to test the rigors of celestial flight.

In November and December. the remainder of the Space Shuttle flight kit -- orbiter main engines, external tank and solid rocket booster motors (SRBs) -- will arrive at KSC. Along with the orbiter, they will enter the test, assembly and checkout pipeline that will culminate in a scheduled launch from complex 39 in March of the following year.

After completion of six development flights. including four landings at the Dryden Space Flight Center. the Space Shuttle will commence operational missions from the Kennedy center in May 1980. KSC was selected in 1972 as the primary launch and landing site for Shuttle operations.

Construction of new facilities and modifications to existing ones are proceeding on schedule at KSC to support the Shuttle's debut.

The landing facility. where the Shuttle orbiter will land on its return to Earth, was completed last August. Supporting facilities such as the mate-demate device, to offload the orbiter from its 747 carrier aircraft, and the microwave landing system, to guide the orbiter to an automatic landing, will be completed in April 1978. Meteorological sites to support landing operations were completed in November 1977.

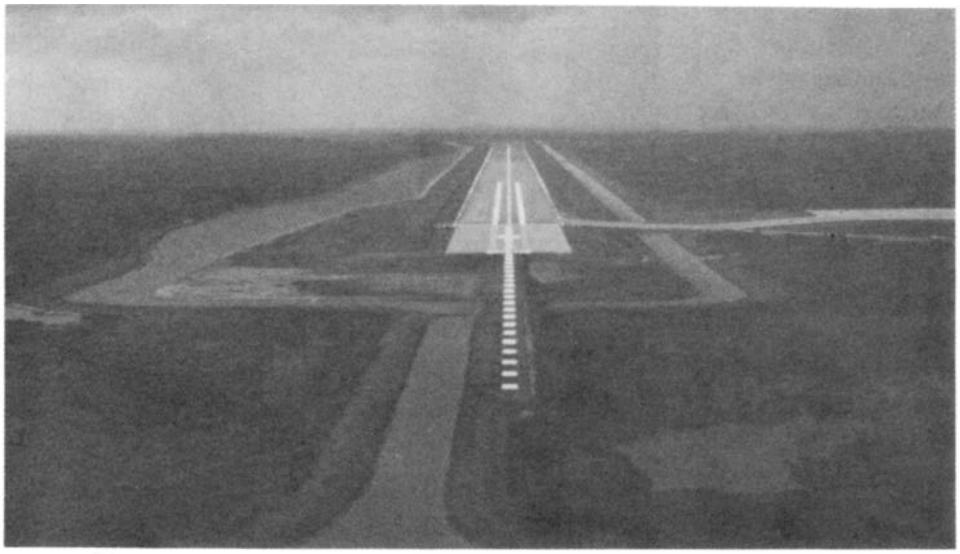
One of the world's longest concrete runways, the orbiter landing facility is 4.5 kilometers long, 91 meters wide and has a 300-m safety overrun at each end. The facility is located northwest of the vehicle assembly building (VAB).

The orbiter processing facility, located adjacent to the VAB and connected to the landing facility by a 3.2-km towway, is essentially completed except for the installation of some remaining stands and systems expected to be in place by April. The two-bay structure will serve as an aircraft "hangar." It is here, in a "clean room" environment, that ordnance and residual fuels will be rendered safe, flight and landing systems will be refurbished and payloads will be removed and installed.

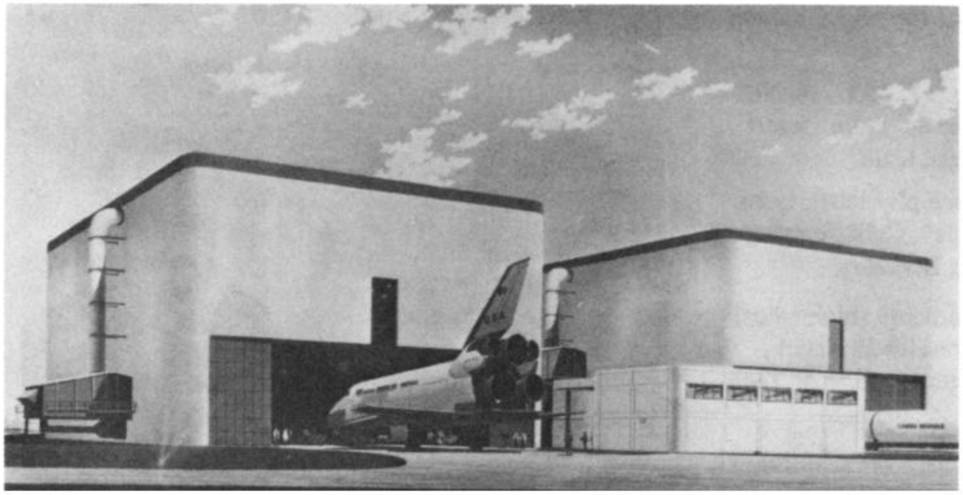
The orbiter landing facility and the orbiter processing facility are the only new facilities required to support Shuttle operations at KSC. The remaining Shuttle preparations consist of modifications to existing facilities originally designed and built to support the Apollo lunar landing missions.

Only one structure on Cape Canaveral Air Force Station will be modified to support Shuttle operations. Hangar AF will be transformed into a solid rocket booster recovery and disassembly facility. It will serve as a receiving and disassembly site for the reusable SRBs after their retrieval from the ocean following Shuttle launches. Modifications, which began in January, will be completed in the last quarter of next year, and will include a barge slip at the rear of the building.

The eventual cost of construction, modification work and ground support equipment to support Space Shuttle operations at the Kennedy Space Center will be about $700-800 million.



Shuttle's Runway



Orbiter Processing Facility—*An artist's view of the almost completed processing facility for the Space Shuttle orbiter, located adjacent to the VAB and connected to the landing facility, at the Kennedy center.*

So You Want To Be An Astronaut?

So you are a would-be astronaut with three strikes against you. . . but you aren’t out yet, by any means. Not by a long shot.

Strike one: you aren’t an experienced jet fighter pilot with thousands of hours of flight time, so you weren’t picked as a pilot-astronaut and have little chance of ever being picked.

Strike two: You didn’t make the ‘Mission Specialist’ selection either, as a test engineer or as a scientist. You might someday, but the odds are not good.

Strike three: You couldn’t get close to the Spacelab ‘payload specialist’ selection panel either. These part-time researchers will be nominated by the panel of “Principal Investigators” who themselves were picked by NASA boards determined to get the most productive science and engineering from each Spacelab mission.

But you are not out., because most of the Space Shuttle seats for the 1980s are still empty, still unassigned. They are possibly still available for use. Only user demand will open them up.

These are the four extra seats on each ferry Shuttle flight, the missions devoted to launching synchronous comsats or other cargo payloads. Nominally, these flights will carry three people: two pilots and an engineer, and will last for one to three days. Their sole purpose will be running freight service into orbit -- but even on earth, freighters carry passengers sometimes, too. One seat on the flight deck, and all three on the middeck, are empty. And that doesn’t count three more possible seats (“rescue configuration”) in the middeck.

Putting people into those four ‘empty seats’ on the freighter missions would not cost much extra, since the weight is negligible and the consumables are standard. So, if it is to be possible to hitch-hike a three-day space ride, how can it be done?

NASA has not set up mechanisms for this, and has not considered it in any detail. But it is these seats which will be used to fulfill NASA’s unwritten promise to send a representative of the news media into orbit in 1981-1982. Other occupants of these seats could be poets, medical patients, visiting scientists, and the President of the United States. And you.

So how? More than curiosity will be needed as justification. Propose an experiment or some other activity to NASA. Create a market, and compel the Space Shuttle management to consider this option.

Fill those seats! Forget the three strikes: the game has just begun.

Astronaut Candidates Selected

NASA Administrator Dr. Robert A. Frosch recently announced the selection of 35 new astronaut candidates for the Space Shuttle program. The group will report to the Johnson Space Center July 1, 1978, where they will join the astronauts currently on flight status.

NASA received 8,079 applications during a year-long recruiting period which ended June 30, 1977. Since August, 208 finalists have been interviewed and have undergone medical examinations at the Johnson center.

After two years of training and evaluation there, successful candidates will become astronauts and enter the Shuttle training program leading to selection on a Space Shuttle flight crew.

Those chosen as pilots will operate the Space Shuttle orbiter, maneuvering it in Earth orbit and flying it to Earth for a runway landing. Mission specialist astronauts will be responsible for the coordination, with the commander and pilot, of Space Shuttle operations involving crew activity planning, the use of consumables, and other Space Shuttle activitiesaffecting experiment operations. They may participate in extravehicular activities (space walks), perform special payload handling or maintenance operations using the Space Shuttle remote manipulator system, and assist in specific experiment operation at the discretion of sponsors of given experiments.

The newly selected candidates include 14 civilians and 21 military officers. Of the group, six are women, and four are members of minority groups. Currently there are 27 astronauts on active status (17 pilots and 10 scientist astronauts) and one on leave of absence.

The new astronaut candidates are:

Maj. Guion S. Bluford, 35, Air Force engineering specialist, from Dayton, Ohio
Lt. Cdr. Daniel C. Brandenstein, 35, Navy pilot, of Oak Harbor, Wash.
Capt. James F. Buchli, Marine, 32, of Lexington Park, Md.
Lt. Cdr. Michael L. Coats, Navy pilot, of Great Mills, Md.
Maj. Richard O. Covey, Air Force Pilot, 32, of Fort Walton Beach, Fla.
Lt. Cdr. John O. Creighton, 32, Navy pilot of Lexington Park, Md.
Maj. John M. Fabian, 39, Air Force astronautical engineer, of Colorado Springs.
Dr. Anna L. Fisher, 28, physician, of Rancho Palos Verdes, Calif.
Lt. Dale A. Gardner, 30, Navy physician, of Camarillo, Calif.
Lt. Robert L. Gibson, 31, Navy pilot, of Leonardtown, Md.
Maj. Frederick D. Gregory, 37, Air Force pilot, now attending the Armed Forces Staff College in Norfolk, Va.
Stanley D. Griggs, 38, NASA engineer, of Seabrook, Texas.
Terry J. Hart, 31, Bell Telephone Laboratories engineer, of Long Valley, N.J.
Cdr. Frederick H. Hauck, 36, Navy pilot, of Oak Harbor, Wash.
Dr. Steven A. Hawley, 27, astronomer, of Santa Cruz, Calif.
Dr. Jeffrey A. Hoffman, 34, astrophysicist at the Mass. Institute of Technology.
Dr. Shannon W. Lucid, 35, biochemist, of Oklahoma City.
Lt. Cdr. Jon A. McBride, 34, Navy pilot, of Edwards, Calif.
Dr. Ronald E. McNair, 27, physicist at the Hughes Research Laboratories, Malibu, Calif.
Capt. Richard M. Mullane, 32, Air Force engineer, of Fort Walton Beach, Fla.
Capt. Steven R. Nagel, 31, Air Force pilot, of Edwards, Calif.
Dr. George D. Nelson, 27, astronomer at the University of Washington, Seattle.
Capt. Ellison S. Onizuka, 31, Air Force engineer from Kealakekua, Hawaii.
Dr. Judith A. Resnick, 28, electrical engineer, Xerox Corp., El Segundo, Calif.
Sally K. Ride, 27, researcher at Stanford University, Calif.
Maj. Francis R. Scobee, 38, Air Force pilot, of Edwards, Calif.
Dr. Margaret R. Seddon, 30, surgical resident at the Memphis City Hospital, Tenn.
Capt. Brewster H. Shaw, 32, Air Force pilot’ of Edwards, Calif.
Capt. Loren J. Shriver, 33, Air Force pilot, of Edwards, Calif.
Maj. Robert L. Stewart, 35, Army aeronautical engineer, of Edwards, Calif.
Kathryn D. Sullivan, 26, geologist, of Cupertino, Calif.
Dr. Norman E. Thagard, 39, a physician, of James Island, S.C.
Dr. James D. van Hoften, 33, engineer, of Houston, Texas.
Lt. Cdr. David M. Walker, 33, Navy pilot, of Virginia Beach, Va.
Lt. Cdr. Donald E. Williams, 36, Navy pilot, of Lemoore, Calif.

BE YOUR OWN ASTRONAUT

by Paul Siegler

Would you like to be an astronaut? Robert Truax, of Saratoga, California, thinks he has just the solution. For $1 million, he'll put together a launch vehicle which will lift you to 50 miles -- to the edge of space. From your vantage point in the rocket, you'll briefly be able to view thousands of square miles of the earth's surface, as well as peer into the near-black of interstellar space. This-the dream of a rocket pioneer from the beginning of our nation's space program.

Robert Truax has experience in designing rockets. After leaving Aerojet General, he built a steam-rocket powered racing car. He's also the person responsible for building the rocket which lifted Eve1 Knievel over Snake River Canyon several years ago. Now he's graduated to a more powerful vehicle which can lift a human payload to 50 miles.

Basically a sounding rocket, Truax's vehicle is composed of parts from many other programs. The four 1000 pound thrust engines are surplus vernier engines from the Atlas program. The basic gyros will come from a Nike Hercules, and others parts may come from the X-15 and Polaris programs. The benefit of this technique is to reduce the cost and increase the reliability of the whole program by using tried and true components-thereby saving unnecessary development cost and time, and using parts with known reliability factors.

The vehicle itself will be 24 feet long, with 25 inches outside diameter. (This narrow diameter means the astronaut will be somewhat cramped and will have to squat inside the payload compartment to fit.) Fully fueled, it weighs 3100 pounds; dry, it weighs 1100 pounds. The four engines give a total thrust of 4000 pounds, which means the astronaut will experience a maximum of 3G thrust during ascent.

Before flight, there will be many ground tests to assure as high a reliability as possible. (Truax estimates a 90% to 98% chance for survival in the first piloted flight.) There have already been some tests of the engine components.

On the day of launch, all will be set up at a base near a large body of water-such as the Pacific Ocean or a large lake. According to Truax, the vehicle will be erected on the pad and serviced until almost ready for flight-without the nose cone. Nearby, the astronaut will be put into the nose cone-which has a shirtsleeve environment-and the life support system will be activated. There will be just enough air inside to last 30 minutes. Quickly, a crane will hoist the nose cone with astronaut atop the vehicle, and the countdown will continue on to firing. At liftoff there will be television crews to monitor the whole flight-as well as a TV camera inside the vehicle showing viewers what the astronaut is seeing outside the window. Maximum acceleration of 3G will come at about 100,000 feet. At that point, engines will shut off and the vehicle will coast to 50 miles.

The astronaut will have a clear view of the earth and sky through the window, and will be likely be describing the experience to viewers on the ground through a special communications link. At some point the vehicle may begin to tumble. This tumbling is undesirable, but cannot be remedied until the vehicle is back down to about 100,000 feet altitude. At that point the drogue chute will pop out to stabilize the system and help slow the descent. By the time it reaches 20,000 feet, its rate of descent will have slowed to about 400 miles per hour, and the main chute will pop open. This will be a 48 foot diameter chute of a type tested successfully and used many times. Also, a port will be opened at 20,000 feet to replenish the air in the nose cone. By the time it lands in the water, flight time will have been ten minutes. A recovery fleet will lx on its way in minutes. Truax's recovery fleet consists of a 120 foot cutter with two helicopters and a fixed wing airplane. Skin divers make up part of the team.

The Volks-Rockets, as Truax like to call it, would then be recovered and reused for future flights, and the astronaut will have made headlines across the country. When could all this come about? Perhaps no later than 1980, depending on when funding becomes available. In a sense, Truax hopes his vehicle would be the world's first reusable shuttle. And therein lies part of the object of his intent. He's doing this not just to make money (and let there be no doubt that monetary gain is one of the objectives), but also to show NASA engineers that they're going in the wrong direction by powering the Space Shuttle with large solid rockets. Instead, Truax feels the best solution is to use "big dumb boosters" of a liquid fuel type. He wants to simplify the overall approach to the Shuttle. To the contrary, he says, the Shuttle program is too sophisticated, making for unacceptable turnaround times. He further feels that a ballistic type recoverable vehicle stands a better chance than a winged glider. A parachute is lighter and simpler than wings, possibly more reliable, having been proven many times in past programs such as Mercury, Gemini, and Apollo. In his words, designing a spacecraft to land at an airport makes about as much sense as designing an aircraft to land at a railroad station.

This project, dubbed Project Private Enterprise, has already evoked considerable interest from the TV networks. As a backup to the astronaut's own one million dollars, the networks would likely pay almost the whole amount for viewing rights. Most of the gain from this first flight, says Truax, would be used to make the system even more reliable. Subsequent flights would cost but $10,000. Who's interested? Truax has already had several people approach him to be the first astronaut in his vehicle. One potential astronaut is selling T-shirts to try to finance his way. The first person to come up with the money will be the first person to go.

* * *

Like Lutz Kayser of Germany, Robert Truax is moving out on his own, using private capital in an attempt toaccomplish a space first and make some money doing it. Also like Kayser, Truax is using simple components in an attempt to keep the total cost down and reliability high. And it looks like he might succeed.

The requirements are simple. And if you're the first with the million dollars, the TV networks will likely repay you in full. Consider Robert Truax's dream, then, as your opportunity to be the first private astronaut in the world-with all the accompanying benefits. He's waiting to hear from you, right now.

Space Mines, Space Law, and the Third World

by K. Eric Drexler

Can a U.S. company legally mine the moon? Some lawyers say yes, others say no. Some say a special international entity must do the job. The 1967 Outer Space Treaty, the primary source of law on such matters, says:

"The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind." (Article I, first paragraph)

"Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." (Article II)

Jack Salmon states (**L-5 News,** May 1977): ". . . Certainly the mining of lunar materials and their transport into space for construction purposes is more than a strict reading of the treaty permits; J.H. Glazer has even argued that construction of a fixed-orbit colony might be construed as 'national appropriation' of a portion of outer space."

However, a strict reading of the treaty would prohibit activities that are apparently considered to be legal. Current military activities are a use of outer space not "in the interests of all countries," while operation of current communications satellite systems are a use of outer space not "carried out for the benefit . . . of all countries, irrespective of their degree of economic or scientific development." Whatever the first paragraph of article I may mean, precedent suggests that it does not prohibit a nation from using outer space for the benefit of itself or whoever it pleases.

With regard to "national appropriation," we must remember that the treaty says nothing about scale. If collecting a few rocks during project Apollo did not constitute "national appropriation" of the moon, neither will collecting more rocks during mining operations. If orbiting a small inhabited spacecraft for a few days fails to violate the treaty, orbiting a colony for a few centuries can do no worse.

Moreover, since the treaty explicitly permits the use and occupation of outer space, article II can scarcely prohibit them. In fact, article II declares that outer space is not subject to national appropriation by any means whatsoever. This suggests that "national appropriation" is not an accidental byproduct of space activities, but would require a national intent-to-appropriate.

Because all relevant paragraphs of the treaty refer to "outer space, including the moon and other celestial bodies," use of the moon is no more restricted than use of space. Space has been used freely by individual nations and companies with no legal challenge. Because all relevant paragraphs of the treaty refer to "exploration and use," use of the moon is no more restricted than exploration of the moon. A single nation explored the moon (initially) and removed lunar material without legal challenge. Nowhere in the relevant paragraphs does the treaty make any distinction between actions permissible in the use of the moon, the use of space, and the exploration of the moon.

We should also note paragraph two of article I:

"Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality, and in accordance with international law, and there shall be free access to all areas of celestial bodies."

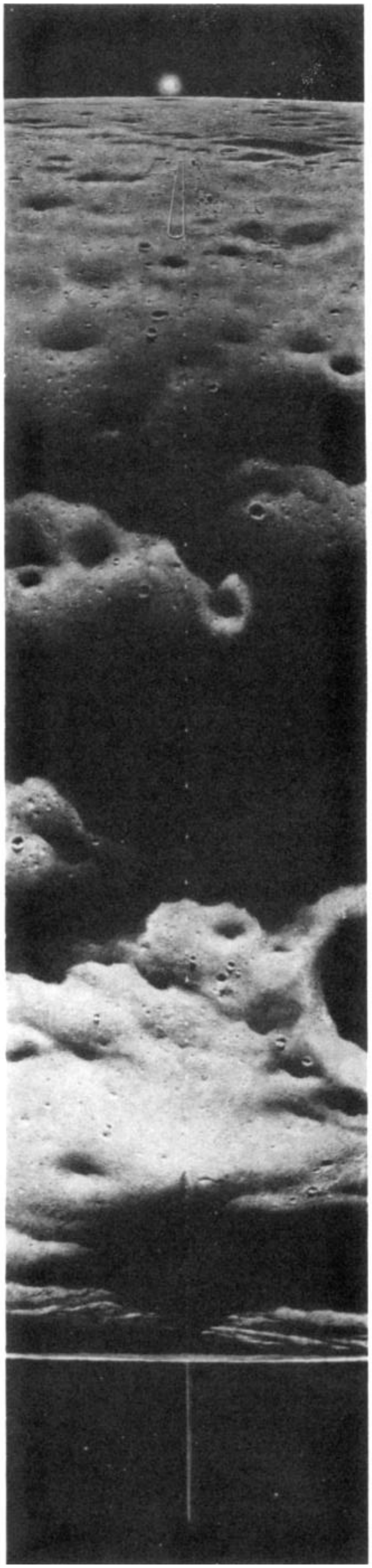
This appears to guarantee free use of celestial bodies by all nations, without need for the special international agreements that some claim are required. Please note that the treaty says nothing to suggest that mining is a special or proscribed form of use.

Article IV states:

"States party to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried out by governmental agencies or by non-governmental entities . . . "

This appears to imply the right of nongovernmental entities, including companies, to operate on the moon or other celestial bodies.

To summarize, no precedent exists for interpretations of the treaty which would require special international agreement to permit use of outer space, including the moon and other celestial bodies. No precedent exists for interpretations requiring specially negotiated international distribution of benefits from such use. Precedent exists for removal of lunar materials, and the treaty does not suggest



A mass driver flinging lunar ore into space.

that such activities constitute national appropriation of the moon. The treaty establishes that non-governmental entities may carry out activities in space under national supervision. From this we may conclude that U.S. companies can, with federal permission and oversight, legally mine the moon.

I am not a lawyer, and the above interpretation may prove faulty. If so, article XVI provides a way out:

"Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depository Governments. Such withdrawal shall take effect one year from the date of receipt of this notification."

The 1967 Outer Space Treaty seems incapable of blocking space mining, but more than just signed treaties affects international relations. Many have suggested seabed mining as a legal analogy to space mining. Fruitless negotiations continue on a comprehensive Law of the Sea Treaty (see L-5 News, January 1978). Disagreement in these negotiations centers on the concept of the "common heritage of mankind," which supposedly describes the seabed and other extra-national resources. Developing countries are said to "contend that the concept prohibits the United States, or any other nation with the technological ability to do so, to develop these resources or reduce them to possession." Regardless of treaties, this position could pose a political problem if extended to space resources. The developing countries' reflex response to talk of space mining seems to be "Stop! Leave some for us!" Need such conflicts arise?

The developing countries have good reason to block exploitation of the seabed. Exploitation of seabed resources by the advanced nations would hurt some developing economies by undercutting the market for their mineral resources, which are all many of them have to sell. Exploitation could well deplete seabed resources before the developing countries become capable of benefiting from them. They have nothing to lose and everything to gain from delay.

Nevertheless, the developing countries have good reason to favor exploitation of space. Space will return energy (and eventually materials) at a future time when the world's supplies may be running short and the developing countries' demand should be rising sharply. Exploitation, far from depleting space resources, would make them increasingly available as the developing countries become able to use them. In space, with the long lead times for resource development, the developing countries have nothing to gain and quite a bit to lose from delay.

Much conflict could be avoided if everyone concerned realized that the resources of space are effectively limitless. In every second, the sun pours out a two million year supply of energy. A single asteroid, Ceres, contains resources enough to build a land area over 600 times that of Earth -- assuming we construct enormous, inefficient colonies with lots of dirt. Fears that the developed world could soon gobble up the third world's share of space resources are groundless, yet fears continue.

Educating the world about space resources would dispel these fears, but educating the world is an awesome task. A more practical solution would be to make a dramatic concession to the developing countries. Congress could pass a resolution limiting U.S. exploitation of space resources over the next century (or until an international allocation agreement is reached) to no more than l/1000 of the resources of the asteroid belt, or of the moon, or of any other celestial body, with no more than l/100,000 to be consumed in any given year. Simple calculations show this resolution to be a mere gesture: the U.S. couldn't come close to exceeding this limit if it tried. Now, consider the propaganda value: "Look! We're opening space to the world and using less than our share of its resources. In fact, we are leaving over 99.9% to the future and to the third world!" Such a resolution would help defuse objections to space mining, and help to shock people into a sorely needed new pattern of thinking.

Russia's BIOS-3 Mini-Colony

Some years ago, back in 1972/73, the Soviet Union conducted a six month experiment of a closed-loop environment using people and higher plants. This small-scale experiment has many fascinating aspects that have relevance to space colony design. The BIOS-3 experiment points successfully to the possibility of totally closed ecological systems on space colonies.

The BIOS-3 unit comprised a stainless steel body of 9 x 14 x 2.5 meters with four compartments. Two compartments were called phytotrons and housed, at different stages of the experiment, higher plants such as wheat and vegetables, while the third compartment was used, at some stages, to house Chlorella unicellular algae. The fourth compartment was the crew compartment with three cabins, kitchen, laundry, toilet and washing facilities. Each phytotron had 20.4 sq. meters of growing area, each equipped with trays for aerial sub-irrigation culture of wheat and for growing vegetables in hydroponics on a porous clay filler, a system for distributing nutrient solutions and for ventilation and heat dissipation. Twenty valves were installed to imitate sunshine guides. The rated capacity was 1,000 liters of oxygen per 24 hours per phytotron. The food requirements of the three man crew were provided by the higher plants.

A six month program was carried out with the BIOS-3 unit. The first stage of the experiment lasted two months. They used the two phytotrons in a "man-higher plant" system. The two phytotrons were planted with wheat, Bordeaux cabbage, Chante carrots, Dill, Petrovsky turnip, Peking leaf cabbage, Virovsky white raddish, Batun onions, Din-Zo-On cucumbers and sorrel. Culture conditions were 145-l80 W/m^2 of uninterrupted illumination, an air temperature of 22-25°C relative humidity of 72-78% and a carbon dioxide concentration of 0.2-1.5%. The results from this first stage were very encouraging and seemed to point the way to a successful cycle of closed ecological systems. However, for the second and third stages of the experiment, one of the phytotrons was replaced by a compartment of Chlorella. In the second stage, wheat was planted. It appears that the wheat was severely affected by the presence of the Chlorella in the system and the toxic levels in the vegetables also rose. The third stage saw only the vegetables and Chlorella being planted and grown. Again, high toxic levels were found although the crew were able to function normally. It seems the toxicity was due to the presence of the chlorella in the system. The overall result of this experiment, however, is that it does appear to be possible to create a biological life support system within limited space and that that system be controlled from within i.e. space colony style.

(PJP)

(Readers of the above article are directed to a more detailed account of the BIOS-3 unit and the results from the experiments contained with 'Acta Astronautica', Vol. 3 pp.633-650 under the title "Life support System With Autonomous Control Employing Plant Photosynthesis' by I.I. Gitelson, et al, of the L.V. Kirensky Physics Institute of the Siberian Branch of the USSR Academy of Sciences, Krasnoyarsk, USSR).

From the Center -
T.A. Heppenheimer

Compliments And Caveats

The Soviets have made a noteworthy accomplishment. Climaxing a decade of concerted and often disappointing effort, they have succeeded in establishing a space station in orbit. Their Salyut 6 has supported the cosmonauts Grechko and Romanenko in orbit for some three months, as this is written; and they have successfully resupplied the orbiting Salyut via shuttle rockets from Earth.

In the history of astronautics, the permanent space station is a desideratum which has served to focus effort and study from the earliest days of the science. The classic concept is the orbiting wheel of von Braun or of Arthur Clarke -- a design closely resembling the Stanford Torus space colony. Indeed, a quarter-century ago, von Braun's ideas were receiving the same sort of attention as the ideas of space colonization are receiving today.

In the real world, the early von Braun and Clarke concepts have not been realized. Yet the Salyut must be regarded as a true space station, albeit one not so elaborate as one might wish. Such a statement follows from an understanding of the question: What is a space station? What is the threshold which separates a true space station from a long-duration manned orbiting flight?

I think the common judgment would be that this threshold consists of maintaining the station as a long-term facility, resupplied by flights from Earth. This is distinct from even a very long flight by a spacecraft, if that craft is not resupplied but instead returns to Earth after its mission.

The U.S. Skylab was also a space station; it was abandoned after being in use less than a year. It may yet see further service in the shuttle era. Plans are afoot for an early shuttle flight to boost it to-higher orbit; but such plans must go forward quickly, for Skylab's orbit is decaying.

There are several ways in which these early space stations are pertinent to the goal of space colonization. One is that the history of the space station may be, to an extent, repeated: Twenty-five years after the initial public discussions of elaborate concepts, there may be space systems which, while much less elaborate, still truly accomplish the goals of those earlier ideas.

What, then, would be a threshold for space colonization? How would one distinguish a large space station from an embryonic space colony? I would argue that the difference is reliance on nonterrestrial resources: Once there is a lunar mine and a mass-driver serving a space manufacturing plant, then we will be at the "Salyut 6" stage of space colonization.

But will the Soviets play a leading role? Here the technical gulf between a space station and a space colony yawns wide. For operations in high Earth orbit, or on the Moon, the use of hydrogen as a propellant is essential. The Soviets have yet to demonstrate its use. We flew our first hydrogen-fueled stage in 1962.

Beyond that, for all the hopes of U.S. -- Soviet space cooperation, there still is this: The U.S. space program is civilian in character; the Soviet's is entirely controlled by their military. It is the Soviet army and air force which set their priorities in space. And no consideration of space cooperation can ignore this.

SALYUT-6 FACTS & FIGURES

JAMES E. OBERG

The following data is extracted in rough arrangement from the Soviet press, describing various features of the mission of Salyut-6. Soviet sources have been quite explicit and forthright about many aspects of this mission, but, regrettably, much of the interesting data has not been relayed to the Western public.

The Salyut-Soyuz combination weighs in excess of 26,000 kg and has an interior volume of more than 100 cubic meters. The length of the complex is more than 20 meters. The Salyut has three cylinders: the transfer compartment, sealed at each end by a hatch, and possessing a 'side-door' for EVA-this compartment is about two meters in diameter and 2.5 meters long. Next is the so-called 'working compartment' with a diameter of 2.9 meters and a length of 3.8 meters. The widest section of the station houses most of the scientific apparatus (total weight of apparatus: 1500 kg), and is 4.15 meters in diameter and 6 meters long (of which only 4.1 is pressurized -- the rest houses the maneuvering engines, fuel tanks, and aft docking equipment).

Three solar power wings are attached to the middle compartment. They measure 3 by 15 meters and can articulate to follow the sun. Their peak power is 4000 watts, although accounting for battery charging for darkness, normal operating power is 2000 watts.

The maneuvering engines are straddling the docking port at the aft end. Their total thrust is 600 kg. Fuel is not described (NOTE: We suspect it is hydrazine and nitric acid).

The Salyut-6 is a 'heavy spacecraft of a new type.' It has on-board standard equipment which was tested on earlier flights: the 'Stroka' teletype, an installation for recycling water which is 95% closed loop; a spacecraft orientation system based on a rapidly spinning spherical weight which is suspended between magnets and which can be spun up or down along any axis to trim the attitude of the whole vehicle; an improved ventilation system; a modified and more sensitive thermal control system; an automatic navigation system called the 'Delta' which computes orbit, AOS/LOS, sunrise/sunset, and other scheduled events.

The 'Delta' autonomous on-board navigation system is a small computer, about the size of a small suitcase. It connects to a radio altimeter, velocity measuring devices, and astronavigational sensors, and outputs navigation data, via a link to the 'Stroka' teletype. As the station passes over radio beacons in the USSR, Doppler shifts are used to compute radial velocity. Rising and setting of celestial bodies are noted, and the position of the horizon (NOTE: Also, the flow of atmospheric ions past the spacecraft can provide a velocity vector determination to within a degree or two).

The 'Delta' provides data as mentioned

earlier. It automatically switches on/off the station's communications gear. Via a push-button at the end of a cord. the cosmonauts can precisely fix any given moment on board, such as during visual observations, in Moscow time, with exact reference to the orbital position of the station at that moment.

The orbit of the space station complex is inclined to the equator by 51.6 degrees. The standard altitude is about 350 km with a period of 91.34 minutes, which allows for the same azimuth pass over the launch site every second day 48 minutes earlier (31 revolutions apart). The orbit slowly decays due to air drag (NOTE: Rule of thumb, about .02 minutes shorter period per week) so periodic blasts of the maneuvering engine are required. Alternately, the engine of a docked Soyuz or Progress ship can be fired to boost the station. This was done with the engine of Soyuz-26 on December 29, and with the engine of Progress-l on February 5. Since the Salyut was injected into a low orbit by the Proton booster on September 29 (about 220 by 275 km, period 89.1 minutes), the payload had to use up a great deal of fuel to raise itself to the operating altitude at 350 km.

The launch of the Progress-l space cargo/tanker was played up big (well, they deserve the applause). The ship carried 2500 kg of cargo: fresh supplies of oxygen/nitrogen to raise the Salyut cabin pressure, propellants, oxygen regenerators (cannisters containing sheets of potassium superoxide which reacts with air humidity to absorb some CO-2 and give off oxygen), air filters, water, clean clothes, film, letters and newspapers from home, new documentation for experiments, a geographic atlas, a Vesna-2 portable tape recorder with music cassettes, and various pieces of unspecified scientific gear. The total spaceship weight was given as 7000 kg. Externally it is said to closely resemble the Soyuz, with a higher level (if that's possible: Ed) of automation. The service module is slightly enlarged. The Soyuz command ('descent') module is modified by removal of heat shield, parachute, couches, periscope, etc., and installation of tanks of fuel, oxidizer (Not liquid oxygen as an ignorant Western correspondent guessed), oxygen and nitrogen for the cabin air, and gas to pneumatically push the fluids into the tanks of the Salyut. The Soyuz 'orbital module' became a cargo hold, which the cosmonauts could enter. As they removed one bank of supplies, they replaced that volume with trash and spent equipment from the Salyut.

The docking of the Progress to the Salyut-G/Soyuz-27 was done by autopilot. The cosmonauts observed the approach at a console in the Salyut, and if something unforeseen had happened, could push a button to 'blind' the autopilot, halting the approach of the Progress. That was evidently the only control the cosmonauts had over the Progress. They could also turn on the Salyut engines and pull away from a bad Progress.

Progress-l transferred about 1000 kg of propellants and air, so that might be the whole load. The total weight transferred from Progress-1 was more than 2300 kg, so about 1300 kg was 'dry weight.' (NOTE: The Soviet data says that the cosmonauts use of 20-30 kg of material per day of flight, leading to the estimate of a Progress visit needed every 43 to 65 days). Whether that figure also includes air losses during EVA, maneuvering fuel, etc., is unknown. unknown.

The Progress delivered new weighted training (anti-weightlessness) suits for the cosmonauts, as well as medical supplies to replace expired medicines in the lot originally launched on board Salyut-6. Carbon dioxide filters (presumably lithium hydroxide) were also included; as well as new bed linen and new safety straps for the chairs, and more fans.

A **Pravda,** Jan. 24 interview with Academician Boris Raushenbakh states: "Docking with two space vehicles makes it possible to hand over the station and its apparatus to replacement crews 'in flight,' without any interruption in its work.:" this avoids time wasted in mothballing and de-mothballing the station, and switching to and from automatic/remote control. So I suspect this means that Salyut-6 will never be uninhabited again, although this will call for some pretty fancing juggling of Soyuz and Progress ships at the forward and aft docking ports.

The whole Progress unloading took two weeks of almost full time and deliberate work. Special admiration should be reserved for the fuel transfer: I don't like handling nitric acid and hydrazine on the ground, let alone in space. After the transfer, the cosmonauts finished by purging the fuel transfer lines so nothing would contaminate the outside of the Salyut at separation. The Progress did two days of test maneuvers, then fired its maneuvering engine to re-enter over the north Pacific and burn up-thousands of miles short of Canada.

NOTE: The launching of Soyuz-27 seems to have been a makeshift mission whose sole purpose was to get the crew's Soyuz to the forward docking port, clearing the way for the Progress to use the aft port. The failure of Soyuz-25 in October forced the next crew to use the wrong port due to suspicions that the forward port was damaged. With the return to earth of Soyuz-26 and the 'visiting cosmonauts,' the on-board crew was in the configuration they should have been in three months before, but with the additional expenditure of two Soyuz spacecraft/boosters (my guess at cost? In excess of a hundred million dollars each. No wonder the Soyuz-25 crew had their wrists slapped!)

The rendezvous of the Soyuz-27 was not routine, since the Soviets pointed out that "the Soyuz-26 spaceship was blocking the station's rear radio antennas, (so) the Soyuz-27 had to be (ground) guided not merely into the vicinity of the station, but precisely in line with the forward antennas in order to be in radio contact with Salyut-6." Sounds like a punt to me.

Soyuz-27 also brought new film for the on-board "MKF-6M" multi-spectral earth resources camera, made in East Germany at the Karl Zeiss-Jena plant. An earlier model of this camera was flown on the solo eight day Soyuz-22 mission in September 1976. NOTE: I suspect that film which was launched on board the Salyut-6 in September had expired by the time the Soyuz-26 cosmonauts got there, so new replacement film had to be launched on the next available transport.

The MKF camera is used in the 'Raduga' (rainbow') experiment, which records views of the earth in six bands (not specified); 90% of the photo tasks are for economic purposes, while 10% is for research in remote sensing. Since Soyuz-22, the camera was improved by the addition of an extra electronics backup unit, and two extra film cassette slots were built in. Each picture covers an area of 165 by 220 km, and each cassette carries film for 250 shots.

The two docking mechanisms, at opposite ends of the Salyut, are functionally identical (BUT NOTE: the Progress supply/tanker can apparently only pump fuel in from the AFT docking position). Once a ship is docked, a plastic air hose with installed fan is extended from a position in the station into the cabin of the docked ship.

When the two Soyuz ships were docking to the Salyut in January, there were a total of eight hatches separating the two crews: the command module hatch, the orbital module forward hatch, the docking port hatch, the aft transfer tunnel hatch, the working/transfer tunnel hatch, the forward docking hatch, the other Soyuz orbital module hatch, and the other Soyuz command module hatch.

Russia's first space walk in almost nine years took place on December 20, near midnight Moscow time. The walk had to take place over Soviet territory for communications requirements, but this required that it take place in the middle of the normal sleep cycle and in the dark. This underlined the urgency of the walk, which was to check out possible damage to the forward docking port by the Soyuz-25 docking abort in October (NOTE: It should be recorded here that the crew of that mission, unlike EVERY previous crew, did NOT receive the standard 'Hero of the Soviet Union' award, but instead were granted a much lesser medal, clear indication that they were being held in part responsible for the failure).

The crew was in vacuum 88 minutes but reportedly Grechko only spent about twenty minutes outside, while Romanenko remained in the transfer module monitoring the EVA. Photos released by NOVOSTI show that a work platform, including handrails and restraints, has been installed on the exterior of the Salyut.

The cosmonauts spent the previous two days preparing for the spacewalk, then went to sleep early and awoke a few hours before midnight. After the walk, they stowed equipment and did not go to sleep until about 8 AM, sleeping until 4 PM. Their normal sleep cycle is a standard 8 AM to midnight awake. The EVA really messed it up.

The spacesuit has a 'hard' torso, like a cuirass of medieval armor. In the back of the cuirass is a large hatch, mounted upon which is the autonomous life support system. The cosmonaut enters the suit through this hatch and closes it by pulling on a D-ring attached to the front. Final sealing is accomplished by pulling forward and upwards on another lever on the front of the suit. The suit can be donned unaided in five minutes.

Underneath the pressure suit the cosmonaut wears another suit of elastic tubing through which water circulates for cooling. The control pack is located on the chest, with written instructions inscribed in reverse, since the cosmonaut views the dials of the control pack via a mirror mounted on his arm. The suit is so flexible that the hands can be clasped behind the head, and the gloves are sensitive enough to permit the wearer to handle small instruments or even write with a pen.

The suits are mounted on special racks in the transfer compartment. They are of one basic size to fit all cosmonauts of any height.

The Salyut has an exercycle and a treadmill, along with stress suits such as the 'Penguin' and 'Athlete' gadgets which maintain stress against the muscular and skeletal systems of the cosmonauts. Medical tests are done with a clinical multi-functional apparatus called the Polinom-2M (tested on earlier flights) and the 'Rheograph.'

Another piece of medical equipment is the 'Beta-3' device, which records ballistocardiograms. Tests are made before, during, and after runs on the exercycle, treadmill, and the 'Chibis' vacuum suit (NOTE: This is evidently a 'lower body negative pressure' chamber like that used on Skylab).

The station has about twenty portholes of various sizes. One experiment is to determine the effect of space conditions on the optical properties and surfaces of these portholes. The crew found a scratch 1.5 millimeters deep on one porthole and it is assumed it was caused by a meteorite. In the first 1000 revolutions of the Salyut, only one 'large' particle was recorded by micro-meteoroid sensors.

Another medical device was included: the Amak-3 autonomous microanalyzer for blood samples. Possibly this device was delivered in the Progress-l, since no mention of it was made before January 27.

Footnote: A six month long 'bedrest' experiment under the direction of chief Soviet space doctor Oleg Gazenko was conducted at the 'Institute of Medical and Biological Problems' from October 4, 1976 (note space anniversary connection) through April 1977. Eighteen persons were involved in three groups: six tested preventive measures against the effects of weightlessness, six tested the measures only half as much, and six used no measures at all. All remained prone with their heads slightly lower than their feet. Gazenko is reported to have said at the end of the experiment that "it can be said with certainty that the limit for man's flight in space goes beyond six months."

Biological experiments are also important. The growth dynamics of chlorella algae are being studied, along with the effects of weightlessness on cell division.

An experiment called 'Resonance' involved jumping around in various modules of the complex and observing motion and flexure at joints to other modules. This experiment was done in all combinations of Soyuz/dual-Soyuz/Soyuz-Progress docking configurations.

The 'Medusa' experiment calls for special flasks of bio-polymers mounted on the outside of the station, exposed to vacuum and cosmic radiation. Control flasks are inside the station. They will be retrieved and returned to earth to see if living spores could indeed have crossed open space and begun life on earth.

The crew's adaptation to weightlessness proceeded normally. All negative effects of weightlessness (dizziness, nausea, headache) had disappeared by the seventh day. Every two or three days, readings with the Beta-3 instrument are taken. Every five or six days, a more thorough examination is conducted with the Polinom-2M apparatus.

A 'group for psychological support' has been working to keep the crew psychologically healthy. Cosmonaut mood is monitored via analyzing harmonics in their voices to detect hidden tension. Special projects are undertaken to avoid any possible 'sensory deprivation' problems. Soyuz-27 brought up a tape recorder and cassettes. A videotape recorder and movies are also on board.

Vladimir Shatalov writing in 'Air Transport,' reported by TASS over Radio Moscow on January 16, tells us that the visit of Soyuz-27 crewmen to Salyut-6 means "it will be possible to send 'narrow' specialists for staging some local experiments and then quickly returning to earth." Together with the announcement that there are now "physician-cosmonauts" in training (Russia's first real "scientist-astronauts" since 1964), this suggests that a long endurance flight crew will be occasionally visited by a space medicine expert for a 'house call in orbit' and for tests to determine if the crew can continue their months-long marathon.

COMMENT: With the capability of resupplying ALL consumables of the Salyut-6, all bets on total mission duration are OFF. I would not be surprised to see cosmonauts using the Salyut-6 five years from now. By then, bigger and better things will be in orbit, but Salyut-6 could still be operational as well. And I believe Gazenko: we'll see a 180 day space visit by a crew (or single cosmonaut, as colleagues are rotated) this year.

For the first time, the Salyut crew is maintaining the same working hours as the ground support people in Moscow. This is possible because of improved communication even outside of range of Soviet in-country tracking sites.

For personal hygiene, an isolated sanitation system, and a folding shower (first on a Soviet space station) are provided.

Contact with the Salyut-6 is being maintained via the Soviet in-country tracking sites (Yevpatoriya, Tbilisi, Baikonur, Kolpashevo, Irkutsk, Ussuriysk, and Petropavlovsk) and via tracking ships at sea: the 'Volkov,' newly commissioned, is off Cuba; the 'Gagarin,' flagship of the tracking fleet, is off the coast of Nova Scotia; the 'Komarov' is in the Mediterranean. Smaller ships are in the South Atlantic. The other major tracking ship, the 'Korolev,' is in port. Three new tracking ships are in various stages of sea trials or construction: the 'Belyayev,' the 'Dobrovolskiy,' and the 'Patsayev.'

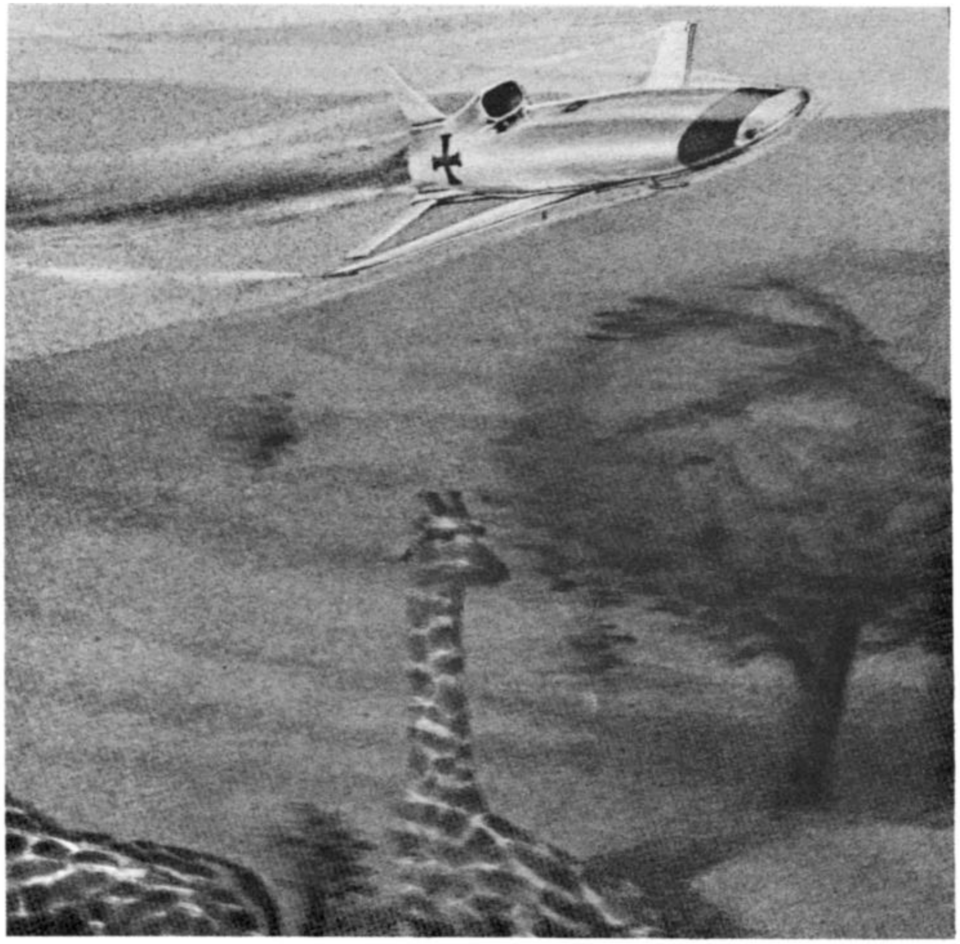
OTRAG News

I have rarely read such a heap of fabrications and distortions as the Tad Szulc article on “Germany Rearms” in the March issue of **Penthouse.**

Szulc accuses the US of being secretly involved with German testing of cruise missiles for nuclear warheads at a secret military center in the Congo-Zaire. His article consists of a series of baseless assertions, phony ‘straw men’, radical cliches inconsistencies internally, and stupidities. Worst of all are the deliberate omissions of facts which do not fit.

The general consensus on Lutz Kayser and OTRAG, and on the space transportation system allegedly being built in competition with French and NASA boosters, is that Kayser is a flamboyant con man raising money for a space-age scam before absconding to Rio. On the other hand, his cheap expendable space launch booster might indeed work. It is barely conceivable that he is a front for someone else, but a few facts reveal the absurdity of that paranoid fraud.

Szulc claims that “weather satellites” are the OTRAG justification. Baloney. OTRAG says that it can build cheap boosters to undersell any client’s need for



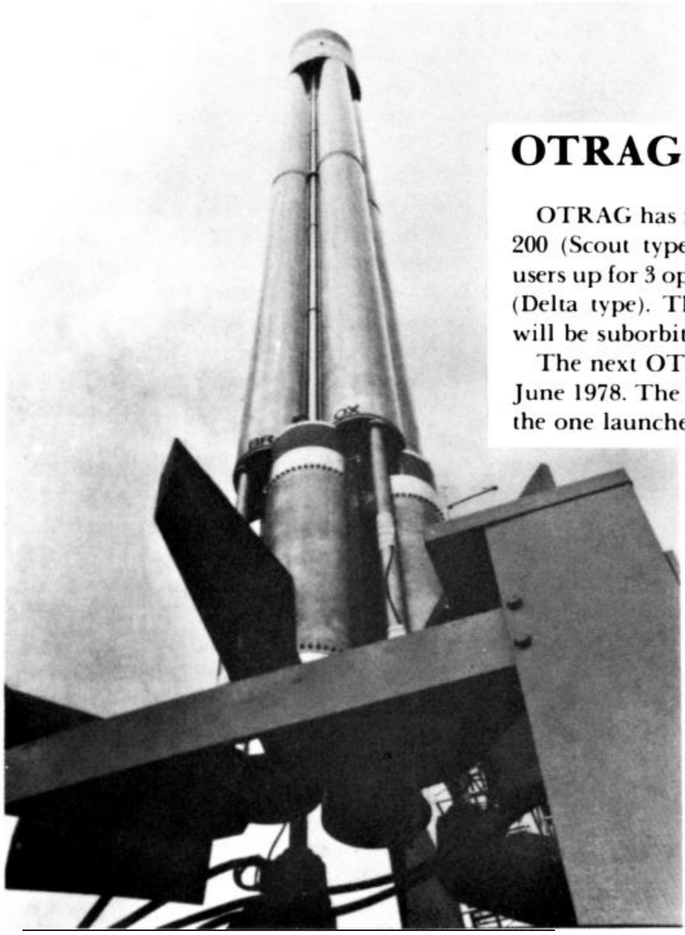
The fantasy: ***Penthouse’s*** *version of OTRAG’s rocket tests.*

The reality: OTRAG’s first rocket test May 17, 1977. Photos courtesy of Theo Pirard.

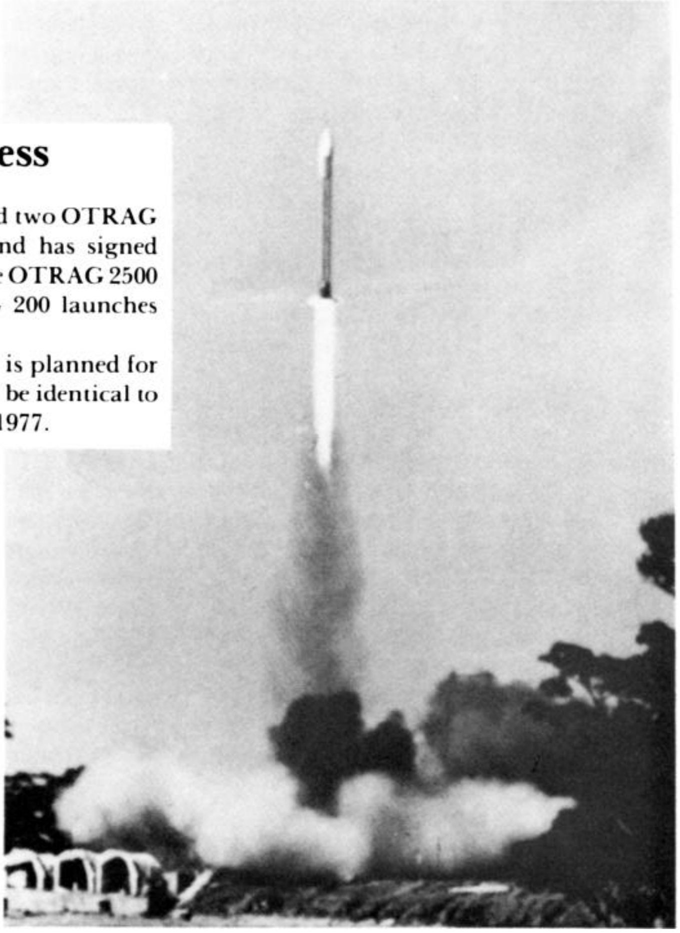
OTRAG Progress

OTRAG has recently sold two OTRAG 200 (Scout type) rockets and has signed users up for 3 options on the OTRAG 2500 (Delta type). The OTRAG 200 launches will be suborbital flights.

The next OTRAG flight is planned for June 1978. The vehicle will be identical to the one launched May 17, 1977.



The first OTRAG rocket: an assembly of 4 independent modules which burn diesel oil and nitric acid.



1st OTRAG rocket is launched successfully from Manono, North of Shaba.

satellite launchings, mainly for communications satellites. An equatorial site makes the most advantage of the earth's rotation speed. Szulc hints ominously about the nature of OTRAG's "clients", but he seems not to know (or want his readers to know) that most artificial satellites launched today by NASA are for private clients.

Inconsistencies: in one paragraph, Zaire receives "vast American economic and military assistance" . . . and in another, "American military aid to Zaire has been kept down to a small volume". Who did Szulc's research?

Stupidities: the assertion that an IRBM with a range of 1500 miles is about to be test fired from a range 300 miles across, make a full duration flight, and return to the test range!

Omissions: The Germans, as part of European space activities, have for more than ten years been working on various rocket stages for orbital launch rockets. The latest is a stage of the 'Ariane' booster now being built mainly by the French for ESA, the European Space Agency. How is this OTRAG activity any more a treaty violation than the earlier space rockets? Who did Szulc's research?

Omission: Moscow has unleashed a major wave of hysterical publicity against the OTRAG activities, seeing in them a good gimmick to whip up anti-German sentiment at home and anti-Western sentiment in Africa. Szulc does not mention this massive propaganda campaign, and why not? Could **his** 'sources' and 'quotes' and various 'high-level hints' all be part of the well-known disinformation activities of the USSR?

Who did Szulc's research? He tells us who by a revealing spelling error. He spells the name of MBB corporation's middle partner as "BELKOV" when it is actually "BOELKOW". It is "BELKOV" **only** on documents in **Russian** or translated from the Russian. Is that where Szulc got all his juicy anti-German "information"? And the third member is "BLOHM" not "BLAUM" as Szulc (and the Russians) mispell it. Caught in his own trap of fabrications?

Szulc's eager participation in the Moscow-inspired anti-OTRAG campaign, and his use of Moscow-supplied information without telling his readers where it came from, must disappoint readers who remember his former journalistic scruples and standards. This OTRAG abortion does not measure up to such standards of accuracy or honesty. His 'accusations' have instead pointed the finger of accusation directly back at him.

James E. Oberg
Associate Editor
SPACE WORLD magazine

While the **L-5 News** may have been the first publication to report on weak points in Tad Szulc's analysis of the OTRAG operation ("Penthouse Slams OTRAG", **L-5 News,** Jan 1978), it is not the only one.

Build your own: you. too can become a cruise missile threat with a powered, flying, 12 inch long scale model of the controversial weapon. Nuclear warheads not included. Write or call Centuri Flying Model Rockets,' Box 1988, Phoenix, AZ 85001. 602/264-0325 for details.

The Feb. 26 **Boston Sunday Globe** carried an article by Andrew Wilson which claims that "it can now be established that the East bloc of countries must have known all along that their allegations about the use of the Zaire range for military purposes are, like stories of the building of a huge military airfield and of OTRAG operating a CIA-type airline. totally without foundation . . . Three basic facts make the OTRAG type rockets unsuitable for military use. First, the diesel -- nitric acid fuel cannot be stored in the rocket tubes without danger of an explosion. . . Second, there are grave doubts as to whether Kayser can lick outstanding problemsof guidance and combustion which make the OTRAG rocket a hazardous vehicle for the launching of hugely expensive spy satellites. Third, the great weight of fuel required (85% of the total launch weight), plus the weight of standard engineering components like valves, raises doubts about the payload that Kayser's larger rockets will eventually be able to carry."

Wilson notes that Tad Szulc's **Penthouse** article bears a "close resemblance to reports in a French Marxist magazine called **Asie-Afrique.** which has been closely following the Soviet line on OTRAG. Wilson reports that the motivation behind these attacks is that "an approach has been made to OTRAG by the Chinese." Observing that they have suspended their space program since 1976. apparently due to launch problems. Wilson reports that "When recently asked whether OTRAG had actually begun negotiations with Peking, Kayser declined to comment. But when asked if OTRAG would be prepared to provide launch facilities for a Chinese reconnaisance satellite, he answered without hesitation. "The answer is yes. I do not see anything wrong with the Chinese doing the same as both the Americans and the Russians have been doing for years." Wilson also reminds us that "Russia is trying to persuade a majority of signatories to the United Nations Space Treaty to amend the treaty with a clause banning the proliferation of spy satellites (which would confirm the Russian-American duopoly in this area)."

The High Frontier

by G.K. O'Neill, paperback, Bantam Books, 1978

Imagine a self-sufficient colonial paradise, hovering between the Earth and the moon, without cars, pollution, heatwaves or blizzards. Imagine being one of thousands of settlers from Earth, helping to build a whole universe of floating worlds.

Gerard K. O'Neill, the world's leading authority on human space colonization -- who first developed this exciting and practical concept in 1969 -- now reveals in documented detail exactly how these wonders can be accomplished within our lifetime in **The High Frontier.**

First published in William Morrow hardcover a year ago, this landmark work was released in a completely revised, updated and illustrated paperback edition from Bantam Books in January. Approximately 60 specially commissioned black and white drawings by Don Davis are featured throughout the book, illustrating the human and technical aspects of colonies in space.

Though O'Neill originated his concept for space colonization eight years ago, it is only within the past several years that it has begun to bear fruit, as NASA and many physical and social scientists, engineers and governmental and business concerns -- who once scoffed at the idea -- have become directly involved in the planning of future high-orbital communities.

Assembling solar panel arrays and concentrating mirrors of power satellite.

In his book, O'Neill predicts that human space colonies -- "communities in which manufacturing, farming, and all other human activities can be carried out" -- will be established by the end of the century. "The normal first reaction to such a statement," he writes, "is disbelief: isn't such a development beyond us? Not at all: the settlement of space by humans could be carried out without ever exceeding the limits of the technology of this decade."

A program of expansion into the "High Frontier," according to O'Neill, would produce substantial benefits, ranging from the immediate and severely practical one of solving the energy crisis we face on Earth, to dealing with the slightly longer-term problem of population size and Earth's capacity to support it, to the non-material yet compelling notion of the opportunity for increased human options and diversity of development.

To that end, his book discusses the concrete plans which could result in such communities. He begins with a first community of 10,000 people, 4,000 of whom would work at building additional colonies, while the remaining 6,000 would produce satellite solar power stations to supply inexpensive, inexhaustible power to earth.

The High Frontier is filled with details of who will work in space and how they will get there; how gravity, agriculture, climate and time will be controlled; how each colony might choose to govern itself; and how, though the initial cost might be as high as $100 billion,. each colony will eventually pay for itself through the opening of new sources of energy and materials, while preserving our environment.

Gerard K. O'Neill is a Princeton University physicist whose studies on the humanization of space began in 1969 as a result of his undergraduate teaching. Dr. O'Neill was selected by the editors of **Aviation Week** as one of the Americans who contributed most to the development of the aerospace field in 1975. During the 1976-77 academic year, while on sabbatical leave from Princeton,' he visited the Massachusetts Institute of Technology as the Jerome Clarke Hunsaker Professor of Aerospace. Most recently he was named recipient of the 1977 Phi Beta Kappa Award and was also the subject of a feature profile on CBS-TV's "60 Minutes." Dr. O'Neill lectures frequently and has contributed many articles on space colonization to scientific publications.

Lobbying for Space

by Robert A. Freitas, Jr.

Review by Carolyn Henson

Lobbying for Space is a privately published pamphlet which contains everything you could possibly want to know about the politics of space in the United States. Subtitled "The 1978 Space Lobbyist's Handbook", it is up-to-date and crammed with facts ranging from the history of NASA funding to the space related voting records of all the members of Congress. It tells you how the NASA appropriations process works, how to write effective letters, and where to write. It contains a listing of over 100 space oriented publications, including addresses and capsule descriptions, as well as the text of the 1967 Outer Space Treaty and the maps of all the Congressional districts.

In order to receive this 63 page pamphlet, send a check or money order for $4.20 to: Space Initiative, Box 353, Santa Clara, CA 95050

I hear that you have a copy of **Lobbying For Space** by Robert A. Freitas Jr., and that you are considering reviewing it soon in the pages of *L-5 News*. You might be interested in the field testing that I have been giving it. Herewith, some statistics. Before I acquired a copy of **Lobbying For Space,** I had written a grand total of one letter to our federal government in my entire lifetime. Now, however, armed with the names, addresses, and zip codes in the pages of my **Lobbying For Space** handbook, I have been averaging about one letter per week encouraging, or chastising, various public officials for their stand on our space program. I call that a dramatic improvement. And I hope that you can convey my feelings for the tremendous utility of **Lobbying For Space** to the readers of **L-5 News.**

Jonathan Boswell
Charlottesville, VA

A Call for Space Literature

The **Michigan Quarterly Review,** formerly a literary magazine, has become an interdisciplinary journal devoted to exploring significant issues. The spring 1979 issue will be devoted entirely to the theme, 'The Moon Landing and its Aftermath.' The publication hopes to assemble as much as 200 pages of essays, memoirs, interviews, fiction, poetry, graphic works-writing in any literate form-that will illuminate the last decade of space consciousness.

It is looking for work that is thoughtful, original. a new perspective on a much publicized event. Not public relations material, but creative, individual responses. It welcomes material of any length. though anything beyond 30 typed pages stands a poor chance of being selected. All manuscripts must be accompanied by a stamped, self-addressed envelope. Payment is on acceptance and runs about $5 to $8 a printed page. Deadline is Nov. 1, 1978.

It is interested also in graphic materials, particularly photographs. previously unpublished, to accompany the texts.

Submissions or requests for additional information should be sent to: Laurence Goldstein, Editor, **Michigan Quarterly Review,** 3032 Rackham Bldg., Ann Arbor, Mich. 48109. Telephone number is (313) 764-9265.

Bibliography Update

by Conrad Schneiker

California Suggests Secession
New Times, November 25, 1977

This article appears unconnected with space. But among the ". . . top aids of California Governor Jerry Brown [who] have supplanted their dreams of national glory with the pleasant little fantasy of secession" is Stewart Brand. Brand has popularized space colonies via the Co-evolution Quarterly and a recently published book. He also introduced Brown to the idea. The result was California's Space Day and a shift in rhetoric from the "Era of Limits" to the "Era of Possibilities," reflecting Brown's new passion for space. Brown pointed out that California's budget surplus is roughly the size of NASA's funding for the year. California's "GNP" ranks high compared with the GNPs of developed countries, California has astronaut Rusty Schweickart as an advisor. Note "Sacramento's stand in favor of solar over nuclear power. . . " in contrast to "plutonium and gas-crazy Washington." Nothing solid here but it makes for interesting speculation. What if . . .

Learning to Build Large Structures In Space
Thomas Hagler, Herbert G. Patterson, C. Allen Nathan
Astronautics & Aeronautics, December 1977

Suggests orbital demonstration projects to verify space construction techniques and technology needed for building large space structures.

Return To Mars
Richard C. Hoagland
Analog, May 1977

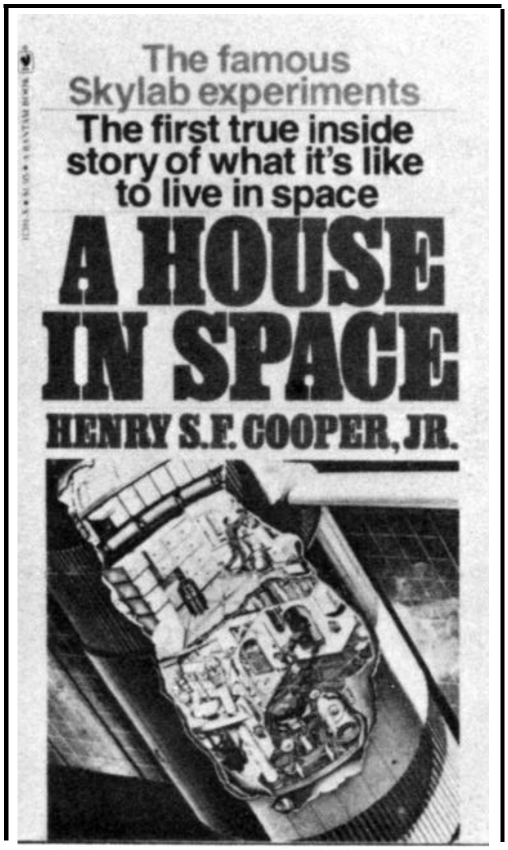
Describes possible manned and unmanned trips to Mars that are made possible using solar sails put in space by the space shuttle. Note: these are what might be termed "old technology" solar sails in contrast to the newer, more efficient "built in space" designs.

Space Roles For The Less Than Super-powers
James J. Harford
Astronautics &Aeronautics, December 1977

At the 28th International Astronautical Congress, Arthur C. Clarke (and others) criticized O'Neill's paper for his cost estimates of space industrialization. Clarke guessed that they were low by a factor of a hundred, contrary to every major study on the subject. O'Neill rejoined, "I propose a codicil to the third Arthur Clarke theorem, 'after engineers and scientists go on record with expressions of opinion, no matter what data are presented, no opinion is going to change.' " (Clarke's law concerns the fallability of distinguished old scientists who go on record stating that something is impossible to do.)

Frontier Law
Arthur M. Dula
Analog, August 1977

The development of space law and the major factors that have shaped it are discussed. "A continuing question that will face space law in the distant future will be which system of laws will direct the lives and economic production of the people who live in space. At the present time we have two candidates for the position: free enterprise from the United States and central state planning from the Soviet Union."


The famous Skylab experiments
The first true inside story of what it's like to live in space
A HOUSE IN SPACE
HENRY S.F. COOPER, JR.

Bantam Books, 1978

How does it feel to live in space? What is it like to eat, sleep, breathe and communicate in a gravity-free atmosphere?

The recent Skylab program -- our first successful experiment in living in space-provided some of the answers and probably has even greater significance for the future of space exploration than the Apollo moon missions. The first book to present in sharp, behind-the-scenes detail just what happened aboard Skylab, *A HOUSE IN SPACE* by Henry S.F. Cooper, Jr., was published in paperback by Bantam Books on February 1. Fifty-four extraordinary NASA photographs are interspersed throughout the text of the Bantam edition.

Called by Isaac Asimov "an encyclopedia of gravity-free life that ought to be on the shelf of everyone interested in writing or reading science fiction" *A HOUSE IN SPACE* describes life on Skylab from the launching and arrival of the first astronaut crew on May 26, 1973, to the departure of the third and final crew on February 8, 1974. That last crew of three men had lived in space for 84 days, the longest period in the history. Their "house in space" was a "can" (as they called it), 48 feet long and 21 feet in diameter, orbiting the earth every 93 minutes at a distance of 269 miles. Now abandoned, it is still in orbit.

The book gives a vivid reconstruction of Skylab's workday regimen, the relationships among the different crews and with ground control (the crews conversations are made public here for the first time), the scientific findings and accomplishments, and all of the expected and unexpected problems of people living and working in weightlessness. Focusing on the third and last of the crews, the author profiles the three men who stayed up the longest and proved the most independent, causing some unprogrammed differences with ground controllers.

"The best part of *A HOUSE IN SPACE,"* said Apollo astronaut Michael Collins, Director of the National Air and Space Museum, "is Cooper's ability to describe the astronauts as individuals, each quite different from his crew mates, rather than homogeneous automatons."

Henry S.F. Cooper, Jr., is a staff writer for **The New Yorker** who has specialized in covering the NASA space missions. His accounts of the Apollo program were among the most popular and highly regarded reportage on our first ventures into space and were the basis of three successful books: **Apollo on the Moon, Moon Rocks,** and **13: The Flight That Failed.**

The REALITY of the NEAR FUTURE -- 1992

A Course Offered at California State University, Northridge, California (Sociology 396D), Summer Session, June 27 - August 4, 1978.

Course Objective: The focus will be on the sociological dimensions relating to the possibilities of creating a better life in space and on earth by investigating the problems involved in the development of community social and cultural systems for large space habitats. In order to bring home the near reality of the whole venture, some speakers will *cover* the technological parameters and current possibilities for actually building habitats in space and working in them. Others will consider the impact life in space will have upon people in space communities and here on earth.

Course Outline:

I. The Near Reality of Living and Working in Space: Getting There, Building There, Working There, and Living There.
II. The Impact for Earth: Technological, Economic, Political, and Social.
III Difficulties and Risks: Military, Political, Economic, and Social.
IV. The Chances for Making a Better Life for Humankind: Effects on the Third World, Humanity's Changing Consciousness, Planning for Freedom, and Life Beyond the Galaxy.

Some **Possible** Topics:

"Star Wars: What is Technically Possible Today"

"Industrialization -- The Long Range View and the Near and Immediate Steps"

"Getting There via Shuttle and Space Lab"

"Consequences of Isolation and Confinement"

"Breaking the Limits to Growth -- Economic, Social, and Personal Implications of Space"

"War and the Military in Space"

"The Extraterrestrial Imperative: The Next Step in the Evolution of Man's Social Life"

"The Evolution of Consciousness"

"'Space is for People"

"New Products from Space: Optics, Medicines, Electronics, Metals, etc."

"What the Future will Look Like -- a visual and auditory preview"

"Building New Community Systems in Space"

"Solar Power"

FEATURES:

Talks by about fifteen people now working on space activities in Private Industry, NASA, the military, and the university;

Trips to see the Orbiter being built and other space technology;

Luncheon Meetings where 3 to 4 people will have lunch with at least one of the speakers;

Slides and Space Materials from NASA and Private Industry will be made available for teachers for use in their classes;

Development of Units on Space Settlements can be selected by teachers as a term project;

Class Discussions of how man can make a better life in space and for the earth.

SOME OF THE PARTICIPANTS WILL BE:

Richard Johnson, Ph.D.
Chief of the Biosystems Division
NASA/Ames
Director of the 1975 study on Space Colonization and Member of the Viking biology experiment team.

Eric Burgess
Co-founder of the British Interplanetary Society
Author and lecturer on Space

Charles L. Gould
Project Manager for NASA Space Industrialization Contract,
Rockwell International Corporation

J. Peter Vajk, Ph.D.
Staff Scientist of Science Applications, Inc. on long range planning for NASA on space industrialization;
Author of an article, "The Impact of Space Colonization on World Dynamics" and a forthcoming book, Foundations For a Choiceful Future which examines the emerging potential for humanity on Earth, both in outer space and inner space.

Captain Stanley G. Rosen, USAF
Space and Missile Systems Organization
Author of "Mind in Space"

Harrold Emigh
Planning and Design Systems for Space Transportation
Rockwell International Corporation

Faren R. Akins, Ph.D.
National Research Council Research Associate
Effects of Isolation and Confinement
NASA/Ames

and others . . . .

This Program is being supported by a grant from Rockwell International Corporation.

For Further Information:
Call or Write: Dr. B.J. Bluth
Associate Professor of Sociology
California State University,
Northridge, Ca. 91330
213-885-3591 (Leave your number and a good time to return your call)

If people want to register for the course by mail, the following information is important:

All mail registration must be made between May 1 and May 26.

All fees must accompany the application.

Audit or Credit at $39.00 per unit	$117.00
Student fees	11.00
Total	$128.00

The application should include the following information:

Name, address, phone, sex, birthdate, class level and present school if relevant, and course and ticket number. Applications will be taken in order of reception.

There is a limit of 48 places in the course.

Send to:
Office of Continuing Education
Calif. State University, Northridge
Northridge, Ca. 91330

Anyone interested in housing can write the Housing Office (same address) or call 213-885-2396.

15th Space Congress

Four generations of Astronauts will participate in a panel discussion with Kennedy Space Center Director Lee Scherer as panel chairman at the Fifteenth Space Congress, April 26, 27 & 28 in Cocoa Beach, Florida, Bill Holmes, Space Congress General Chairman, announced today.

Deke Slayton (Mercury & Apollo/Soyuz Test Project), Manager of the Space Shuttle Orbital Test Flights; John Young (Gemini 3 & 10, Apollo 10 & 16), Chief of the Astronaut Office: Vance Brand (C.M. Pilot - ASTP) Shuttle Orbital Flight Test Training; and Joe Engle, Pilot of the Space Shuttle "Enterprise" will join Lee Scherer in "Meet the Astronauts," a panel session free and open to everyone in the universe beginning at 7:30 p.m., Thursday, April 27, in the Cape Colony Convention Center, featuring opening remarks followed by an audience question and answer period. This will be one of three panel sessions held throughout the S-day symposium.

The first panel, titled "Space Today," will be chaired by John Yardley, Associate Administrator for Space Flight, NASA Headquarters, Washington D.C., and will begin the Congress Wednesday morning at 8:30 a.m. also in the Cape Colony Convention Center.

On Friday, April 28 at 8:30 a.m., the theme of the 15th Space Congress: "Space -- The Best Is Yet To Come" will be the topic of the final panel to be held at the Atlantis Beach Convention Center. Dr. George Morgenthaler, Vice President and General Manager, Martin Marietta Aerospace, Baltimore Division will be Chairman of this panel.

The final event of the Congress will be the Youth Science Fair Awards Ceremony at the Atlantis Beach Convention Center followed by the Patrick Air Force Base Open House featuring The Thunderbirds.

The Space Congress is a non-profit symposium sponsored by the 26 member Canaveral Council of Technical Societies (CCTS), and is held annually in Cocoa Beach, Florida. For more information, write: SPACE CONGRESS, BOX 1333, Cocoa Beach, FL 32931.

SPS Talk

J. Peter Vajk will give a talk on solar power satellites 8:50 PM at the Symposium on Energy Technologies at the Radiation Research Society Meeting in Toronto, Canada May 14.

Before Creation a Presence Existed,
Self-contained, complete,
Formless, Voiceless, Mateless,
Changeless,
Which yet pervaded itself
With unending motherhood.
Though there can be no name for it,
I have called it "The Way of Life"
Perhaps I should have called it "The Fullness of Life,"
Since fullness implies widening into space,
Implies still further widening,
Implies widening until the circle is whole
In this sense
The way of life is fulfilled,
Heaven is fulfilled, Earth fulfilled
And a fit man also is fulfilled:
These are the four amplitudes of the universe
And a fit man is one of them:
Man rounding the way of earth,
Earth rounding the way of heaven,
Heaven rounding the way of life
Till the circle is full

Lao Tzu (604 BC)

Inside the L-5 Society

Raleigh L-5

Raleigh L-5 opened shop on February 11, 1978 with a meeting of co-ordinating members Rupert Hazle, Larry Williams, and Tim Katterman.

Three first objectives include:

a. spreading information about space colonization and industralization when ever and where ever possible.

b. establishing a library of technical information

c. designing fund raising projects to finance research such as Gerard O'Neill's 500g mass driver.

First projects include preparation of statistical testimony for use at the Carolina Power & Light Wake County Nuclear Power Plant Hearing and attending 'Great Decisions 78' -- a group of discussions sponsored by the Foreign Policy Association to help citizens direct U.S. Foreign Policy goals.

Interested people in the Triangle Area should write P.O. Box 5381, Raleigh, N.C. 27650 or call (919) 833-1398 for details of meetings or questions.

Norfolk, VA L-5

Those interest in forming a Norfolk, Virginia L-5 chapter should contact David Howland, 719 Graydon Ave., Norfolk, VA 23507, 622-5983.

Philadelphia L-5

The Space Futures Society here in Phila. is very alive and kicking. Since our inception on Aug. 13, 1977 we have been continually growing and reaching new plateaus of attendance. Two of our most distinguished members, Kenneth McCormick and Jon Alexander have been doing personal lobbying in Washington and corresponding for the L-5 News. A new member, Dr. Lee Valentine, is organizing a spinoff chapter within Jefferson Hospital of Phila. in which he hopes to galvanize Doctors throughout this area into a political lobbying effort. Dr. Lee Valentine has personally supervised a fund raising drive in which $2500.00 has been raised locally for S.S.I. through his efforts. Another member Mark Hess is coordinating efforts to penetrate the war games clubs and is head of an independent committee to design a space colony survival game. Peter Kazlowski is in charge of our NASA film procurement.

Our meetings are now held monthly. We are currently at the Broad and Morris Free Library but starting in June we will meet again at the Central Library on the Parkway. Our first meeting will be 10 a.m. June 10. From July on we will be meeting the first Sat. of every month at 10 a.m.

We had a public lecture and slide show on April 1st at 2 pm at the Marple Twp. Free Library, Springfield and Sproul Rds. Broomall, Pa. 19008. We are also taking part in the "Sun Day" Celebrations on Wed. May 3rd at 7 p.m. in the Central Library. We will also be holding a lecture and slide show on June 3, 1978 at 1 p.m. at the Frankford Y.W.C.A., 4606 Leiper St., Phila. Pa. 19124. We are hoping to have the "Libra Colony" film in time for these lectures.

Houston L-5 Meeting

Public service announcement for Houston area L-5ers: The Houston chapter of the L-5 Society will hold its April meeting on Friday, April 21, at 7:30 PM in the University Center of the University of Houston.

MASC News

The National Governor's Association held its annual meeting Feb. 26 to Feb. 28 at the Hyatt Regency Hotel in Washington D.C. In attendance were 52 of 54 Governors. The Maryland Alliance for Space Colonization (MASC) spent Sunday the 26th trying to gain the attention of the Governors so as to tell them about space solar power. The main thrust of the conference was energy production and conservation. The issues discussed by the Governors included oil and natural gas, coal, nuclear energy, outer continental shelf development, renewable resources programs and energy facility siting.

The topic of solar power energy, however, was not on the agenda. In the course of a press conference we were able to ask Governor Milliken, Chairman and Governor of Michigan, and Governor Jerry Brown of California about space solar power systems.

We asked Governor Milliken "Have you discussed solar power satellites as a permanent alternate source of energy and will you be discussing it as a possibility?" He stated that "It came up briefly and we recognize it as an important issue. . . . . . ." but he felt there were more immediate issues to be discussed at the present conference.

Even more significant and positive were

the statements made by Governor Brown in a later press conference, which was set up at our request. Governor Brown spoke to the media and replied at great lengths to our solar power questions.

Governor Brown underscored the need for increased research on alternate energy sources and especially solar power. He stated that one space solar power station could replace the need for 50 nuclear power stations and that the geothermal energy available in California alone could replace an additional 20 nuclear power stations.

When later we were able to ask him his thoughts on House Concurrent Resolution 451 (introduced by Olin Teague of Texas), he said "Yes, we would like to see much more attention directed towards alternate energy sources." In fact in his opening statement he spoke strongly of alternate energy sources, referring to a large prominent MASC banner, which we had located nearby.

We were also able to talk briefly to Governors Exon of Nebraska and Governor Bolin of Arizona, who requested that we get Dr. O'Neill to send him information on the matter. In general, all of the Governors, members of their staffs and members of the press whom we contacted expressed positive interest, but were uninformed as to space solar power alternatives. Perhaps a matter for local L-5 chapters to pursue!

Michigan "Missal"

The Missal, the newsletter of the Michigan L-5 Society, is still going strong. Following is an excerpt from the March issue.

On January 24-26, Year of our Lord 1978, the Space Science and Applications Subcommittee of the House Science and Technology Committee convened to hold hearings for the purpose of examining our future space program.

The testimony of the first day consisted of industrialists. The most exciting proposal offered was an experimental platform in geosynchronous orbit where studies could be done to determine the feasibility of powersats (earth-based configuration) by the late 1980's. As was to occur several times in the next couple of days, the committee members appeared bored and frustrated at the lack of imagination displayed by the witnesses. This was heartening to L-5 partisans. The only memorable statement was that made by G. Harry Stine concerning cutting back the shuttle fleet from five to four. He made the comment that O.M.B. reminded him of the Senator in 1908 who asked, "Why does the Army need another airplane. They already have one." The legislator also suggested that rather than giving the Army and Navy each an airplane, they could share one and take turns flying it.

The second day's proceedings were more interesting. The witnesses were the president of Martin-Marrietta, the head of the National Academy of Sciences, Gerard O'Neill and Barbara Hubbard. After being placed in a somnolent state by the first two witnesses, Ms. Hubbard's vibrant rhetoric brought the committee room to life. This was what the committee gallery had been waiting for and her words paved the way for Prof. O'Neill. Dr. O'Neill summarized the results of the 1977 NASA-Ames summer study which showed that there were no show-stoppers to the concept. He also showed a film of the M.I.T. mass-driver. The congressmen seemed duly impressed. In questioning afterwards, O'Neill told the committee that he would need a million dollars in the next year to continue his research. Some members expressed astonishment at the low figure. Dr. Handler, N.A.S. chairman, was asked if there were any major technical breakthroughs required for O'Neill's scheme. There was a long pause, seemingly for dramatic effect, and then a reluctant "No." Barbara Hubbard was asked why NASA was not carrying through with these plans. She replied that Dr. Frosch seemed to be committed to limits to growth. Dr. Handler interrupted and suggested that she let Dr. Frosch speak for himself. Chairman Teague concurred and said, somewhat ominously, that he would be given every chance to do so on the following day. We went to bed that night maliciously gladdened at the prospect of Frosch's roasting on a slow spit in the committee room the next morning.

Alas, it was not to be. The NASA administrator was allowed to give his testimony and get away without questioning to attend the appropriations hearing in another building. Before he left, however, he unveiled the space agency's exciting plans for the future: more earth resources satellites and a more advanced communication satellite. He also opened his testimony with the statement that his role was not that of a Columbus, but rather of one of Isabella'scounselors. I'm not sure personally how to interpret this. If I recall my history correctly, Isabella hocked her jewels and funded Columbus against the advice of her counsel. In this light, Dr. Frosch sees himself as an obstructor rather than an originator or facilitator. It is obliquely comforting to see that he is at least consistent; his self-view coincides with his actions. One of the few questions he did answer concerned powersats. His answer was to the effect that while they might be technically possible, he was not convinced or, at best, didn't know whether or not they would be economical. He claimed disbelief of the many favorable cost-benefit analyses done of the subject.

Carter's science advisor, Frank Press, was the next witness. He was destined to receive the flak that should have been reserved for Dr. Frosch. His performance was almost pathetic. Dr. Press had the misfortune of possessing the voice and total lack of inflection of the computer "HAL" from the movie *2001: A Space Odyssey*. His testimony consisted of apologies for the Administration and a feigned enthusiasm for the space program. One of his more outrageous statements, coupled with his monotone, evoked open derision and laughter from the gallery. Re: SSPS. "We simply don't know anything about them." If this is truly the case, perhaps Dr. Press should be replaced by someone who does know something about them. I find it at least disconcerting that someone endowed of such profound ignorance is advising the President.

The foregoing was only a thumbnail sketch of the proceedings in Washington one month ago. My editorializing will be forgiven, I trust, with the realization that this is not strictly a news story, but rather my own impressions and reactions to recent events to which I was a witness. To summarize: I was cheered by the fact that several members of the committee seemed almost as impatient with the Administration as we are. We have several friends in Congress and these friendships should be carefully nurtured with letters and phone calls. In particular, Rep. Scheuer of New York City should be given thanks and support. The most helpful thing that could be done with respect to him would be to write him descriptions of the ways that our program would directly benefit the inhabitants of his district. This was a query that he put to O'Neill that wasn't properly responded to. Anyone who can think of some immediate, direct benefits to the urban areas should send them directly to him or else to us to be relayed to him.

--*The Missal, $3.00/year, Box 126 Michigan Union. Ann Arbor, MI 48109.*

The L-5 Society is attempting to build a comprehensive file of newspaper and magazine articles concerning space; particularly on space colonies, solar satellites, etc. These would be used both to keep track of media and publicopinion, and to have a list of writers and publications which have taken an interest, pro or con, on the subject. Local papers and magazines are as important as national ones in this respect. L-5ers are encouraged to send all relevant articles to the National office.

L5 NEWS

May 1978

L-5 NEWS

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Carolyn Henson, Editor

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In this issue:

1 **SPS Hearings: Momentum Lost?** *Ken McCormick reports.*

2 **Melcher Introduces Senate Solar Power Satellite Bill**

Microwave False Alarm

3 **SPS—"A Gross Perversion of Our Solar Energy Priorities"** *Text of a letter sent by Rep. Ottinger to members of Congress.*

HR 10601: Focus of Controversy *Carolyn Henson reports on the article in* **Mother Jones** *which sparked Ottinger's battle against SPS.*

4 **House Committee Calls for NASA Budget Increases** *Carolyn Henson reports.*

"High Frontier" Bill Update

5 **Microwaves: SPS Hazard** *Eric Drexler explores the political implications of the furor over microwaves.*

6 **Lunar Resources Study Underway** *Carolyn Henson reports.*

7 **Soviet Spacecraft Mysteries Intensify** *Jim Oberg thinks the Soviets are preparing for something BIG.*

9 **Environmental Implications of SPS** *Peter Glaser, father of the SPS, explains which environmental issues have been resolved—and which are still in question.*

12 **Earthport Launch Site Proposal Draws International Response**

13 **Student Programs Called For**

14 **Inside the L-5 Society**

15 **Letters**

Cover: A mass driver reaction engine (MDRE) is ferrying cargo from one orbit to another. In the foreground a second MDRE is being constructed from parts brought up by several space shuttles. (Artwork courtesy Johnson Space Center.)

Back Cover: A chemical processing plant in space which could convert lunar ores into metals, silicon and oxygen. (Artwork courtesy Johnson Space Center.)

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SPS Hearings: Momentum Lost?

by Ken McCormick

Solar power satellites were the subject of joint hearings on April 12, 13 and 14 before the House Subcommittee on Space Science and Applications and the Subcommittee on Advanced Energy Technologies and Energy Conservation Research, Development and Demonstration. Under consideration was a bill, HR 10601, sponsored by Rep. Ronnie G. Flippo, which would establish a solar power satellite (SPS) research, development and demonstration program.

Witnesses testified to the need for more experimental data in several problem areas of SPS evaluation. There was considerable enthusiasm displayed for HR 10601, until government witnesses from DOE and NASA appeared before the subcommittees to attack certain provisions of the bill. By the time the witnesses from NASA and DOE were done testifying, it seemed that HR 10601 had lost some of its momentum.

Undersecretary of the Department of Energy Dale D. Myers began his testimony by reminding subcommittee members that he had undertaken a more vigorous evaluation of SPS at the urging of the Space Science and Applications Subcommittee on February 8. Since then, he said, he had had intensive discussions with NASA administrator Robert Frosch and NASA Deputy Administrator Alan Lovelace on the subject of SPS. It became clear, he said that an SPS project management office should be established within the office of the director of energy research. With Myers was Mr. Frederick A. Koomanoff, the newly-appointed chief of the project office, which will administer the funds appropriated by Congress for the study of SPS.

The existing SPS Development and Concept Evaluation Program, which the provisions of HR 10601 would supersede, calls for an exploratory research plan to be developed by October 1978. Undersecretary Myers said that he had accelerated efforts on SPS research, so as to have the research plan completed for consideration in the fiscal year (FY) 1980 budget.

Myers thus appeared to have pre-empted two of the main provisions of HR 10601: that a program office be established within DOE, and that a comprehensive plan for SPS research be submitted by Sept. 30, 1978. "Based on steps taken by DOE," said Myers, "it is our judgement that the provisions of HR 10601, except for space-related technology development and demonstration, have been accomplished. Both DOE and NASA feel that space technology development and demonstration would be premature."

There remained the provision by HR 10601 for $25 million in FY 1979. Myers immediately addressed himself to this: "We have not at this time identified a requirement for additional funds. Should we find such a need, we will not hesitate to request them in the normal fashion."

Mr. Koomanoff then testified, describing DOE and NASA's formulation of a plan for SPS evaluation. He said that much progress could be made in the SPS systems definition "without extensive new technology development or flight demonstration activities."

Koomanoff then pointed to several potential problems with respect to the SPS microwave beam, including radio interference and biological, ecological and atmospheric effects. He suggested that a number of societal issues yet to be studied are perhaps some of the most serious obstacles to SPS. They include: the question of central versus dispersed power, international space law regarding space usage, international microwave standards, the perceived military threat of SPS, the vulnerability of SPS to attack, the question of energy export, ownership, interface with utilities, regulation, population and individual migration, capital formation, land, materials, facilities, labor and energy requirements.

HR 10601, he said, "would add technology development and orbital demonstration to the present SPS evaluation program. In my opinion, which is shared by NASA, many key systems development and environmental issues must be resolved in the current study before such advanced efforts are warranted. The requirements for . . . experimental equipment will evolve from the current study. The HR 10601 provisions for technology development and orbital demonstration are premature. The present study is properly scaled to the current level of understanding of SPS issues."

Space Science and Applications Subcommittee Chairman Don Fuqua questioned Koomanoff: "Mr. Koomanoff . . . we've had hearings yesterday and this morning and this afternoon by other people who have talked about the need for a continuation of the microwave testing and the environmental effects that that might have. This afternoon, you've heard other witnesses testify that we ought to get on with the program, and I just have difficulty in really understanding your statement."

Koomanoff explained that several microwave test programs were scheduled for the near future and further explained his position: "We have to move piece by piece down the road, because if we don't, then we're going to have too many differences between designs and concepts, and we won't have one overall direction, and that's what we're trying to do, and that's what NASA's in the process of doing right now. They will have their preferred systems concept by October as far as our plan is concerned, and at that time point, then, we can really start moving out in much more detail."

Representative Flippo questioned the men from DOE: "I was wondering, Mr. Koomanoff, or Mr. Myers, if you share the sense of urgency in regard to the solar power satellite that has been expressed by the members of this committee and by the witnesses that have appeared before this committee over a period of time. Do you share that sense of urgency in regard to SPS?"

Myers answered: "Mr. Flippo, I think we share the very strong sense of urgency for new supply. The SPS is another possible new supply area, and we are extremely interested in comparing it with the other systems, and making sure that we as a nation are moving in the desired direction as far as our supplies are concerned. It is a major undertaking. It would be an undertaking which I am sure, in our present views of . . . budgets in the future, would certainly have to take a part away from other systems, so that all of these, to me, have to be compared and the proper balance of programs for this country have to be undertaken."

A DOE technology evaluations section leader who accompanied Mr. Koomanoff to the hearings was perhaps more frank in a conversation with this reporter after the hearings. "Flippo has Huntsville in his district. (Rep.) Gammage has Houston. You can see what they're trying to do. They don't want research; they want hardware. They just want to pump money into NASA. You're looking at something that's far in the future, anyway. What's the difference whether we have SPS in the year 2000, or the year 2005? We're still going to need fossil fuels and nuclear energy."

The next day brought testimony from NASA which echoed that of DOE. NASA Deputy Administrator Alan M. Lovelace appeared, instead of NASA administrator Robert Frosch, who had originally been scheduled to testify. "We are currently working with DOE to determine whether a FY 1980 exploratory research budget request would be appropriate. The space-related technology development and demonstration portions of . . . HR 10601 appear to be premature."

Dr. Lovelace's statement prompted Representative Fuqua to remark: "I realize that there's another agency in town, Dr. Lovelace, besides NASA, and the faceless people at OMB, it appears to me, have put bridles on both NASA and DOE. I would hope that they would come out of hiding sometime, and maybe we need to ask them to come up and testify . . . I am very much disappointed in their (the government witnesses) lack of imagination and enthusiasm for trying to help solve the earth's energy problems."

Dr. Peter Glaser (who first proposed the solar power satellite concept) testified, on the last clay of hearings, that continuing with paper studies alone until 1980 will simply produce a delay of another year in the evaluation of SPS. Nonetheless, the momentum of HR 10601 had clearly faltered, at least temporarily. More than one co-sponsor of the bill remarked that perhaps they had acted prematurely. Advanced Energy Technologies Chairman Mike McCormack stated, "the environmental problems associated with the project may make all the environmental problems associated with nuclear fission look like a Sunday-school picnic." Mr. McCormack was absent from the last day of the hearings, as were most of his colleagues.

Washington, DC May 3: in spite of the heavy opposition to HR10601 that surfaced in these hearings, the Science and Technology Committee voted 30 to 1 (Rep. Ottinger cast the sole "nay" vote) today in favor of the bill. Supporters hope approval from the full House will be obtained by mid-May.

Melcher Introduces Senate Solar Power Satellite Bill

Senator John Melcher (D-MT) has introduced S 2860 which is the Senate version of HR 10601. He informs us that the Senate Committee on Energy and Natural Resources has jurisdiction over the bill. The Commerce Committee, which handles NASA authorizations, did not request jurisdiction over S 2860 as the funds it authorizes go to NASA indirectly through the Dept. of Energy.

Hearings on S 2860 have not been scheduled. First, the House Science and Technology Committee must report HR 10601 to the floor for a vote. If it is passed, the Senate can then go to work on S 2860. If HR 10601 is not scheduled for a vote in a timely manner, it could be delayed so long that it will not be able to pass until the next session of Congress. (Being an election year, Congress plans to adjourn October 6 or 7.) The leaders responsible for scheduling HR 10601 for a vote are Rep. James Wright (D-TX) and Rep. "Tip" O'Neill (D-MA).

If the bill makes it through the House, then the Senate Energy and Natural Resources Committee Energy R & D Subcommittee will hold hearings on S 2860.

Energy R & D Subcommittee members:
(phone 202/224-4971)
Frank Church (D-ID), chairman
Mark O. Hatfield (R-OR) ranking minority member
Spark M. Matsunaga (D-HI)
James Abourezk (D-SD)
Dale Bumpers (D-AK)
Wendell H. Ford (D-KY)
John A. Durkin (D-NH)
Wendell Anderson (D-MN)
John Melcher (D-MT)
Pete V. Domenici (R-MN)
James A. McClure (R-ID)
Dewey F. Bartlett (R-OK)

Other Senators on the Energy and Natural Resources Committee but not on this subcommittee are:
Henry M. Jackson (D-WA), chairman
J. Bennett Johnston (D-LA)
Floyd K. Haskell (D-CO)
Howard M. Metzenbaum (D-OH)
Clifford P. Hansen (R-WY)
Lowell P. Weiker, Jr. (R-CT)
Paul Laxalt (R-NV)

These Senators must vote favorably on S 2860 in order to send it to the floor of the Senate for a vote. If the bill passes—next comes the appropriations process! When that step looms on the horizon we will bring you details on that process.

Microwave False Alarm

The **Washington Post,** in an article dated Feb. 21, 1978 by Thomas O'Toole, reported that solar power satellites (SPS) would "heat the ionosphere to the point of jamming most of the world's police and citizen band radio transmission".

This was reported as the tentative conclusion of scientists at the National Astronomy Atmospheric Center in Arecibo, Puerto Rico," site of the world's biggest radio telescope.

However, before you CB fans rise up in arms to block SPS development — the report was a false alarm. According to W.E. Gordon, who conducted the Arecibo microwave test on the ionosphere, "We heated the ionosphere at frequencies of 10 MHz, 430 MHz and 2380 MHz attempting to simulate the heating effects of the solar power satellite. We looked for communications effects with a sensitive radar properly located to observe any effects if they were to occur. No communications effects were observed in any of the tests! ... If the ionosphere is heated at a radio frequency that resonates with the local ionization, a strong disturbance, an instability, is produced that is known to provide communication paths not normally present." However, adds Gordon, "The solar power satellite would operate at microwave frequencies far too high to excite this instability."

Nevertheless, Gordon does not totally rule out adverse effects of SPS on the ionosphere. "There has been some theoretical speculation that an instability of a completely different kind *might* be produced by strong microwave heating of the ionosphere. This speculation is recognized by the originator of the solar power satellite idea, Peter Glaser, and by the proponents of further study of the idea. The tests we performed last summer and the test we propose using higher powers to simulate the conditions more closely of the solar power, satellite are based in part on this same theoretical speculation ... We and others recommend that additional tests be included in the evaluation of the solar power satellite concept and that the tests be performed at higher power levels."

SPS—"A Gross Perversion of Our Solar Energy Priorities"

(Text of a letter sent to all members of Congress April 11, 1978 by Rep. Richard C. Ottinger, D-NY)

Dear Colleagues:

Solar energy, particularly in its decentralized, locally applied forms, has been strongly supported by both houses of Congress. Now, however, we are being asked to support a massive, multibillion dollar corporate boondoggle—the solar power satellite—all in the name of solar energy!

A Jet Propulsion Laboratory study estimated that the R & D costs alone would come to $60 billion. The industry estimate confirms this, citing a $40-80 billion R & D cost range. The Jet Propulsion Laboratory further estimated the cost, excluding RD & D for a 5 billion watt plant startup in the year 2000 at $26.5 billion. Not only are the taxpayer financed R & D and the capital costs of a solar power satellite horrendous, but the environmental consequences are frightening.

The satellite would use microwaves to beam energy back to Earth. Microwaves, even at low levels, have been shown to cause central nervous system disorders, cataracts, genetic changes and other disorders. You may recall the furor when the Soviets beamed low level microwaves at the U.S. embassy in Moscow.

Both NASA and DOE have ongoing studies of the SPS concept. An ERDA task group in November 1976 recommended a three year, $19 million program for "proof of concept" which is still underway.

Yet the giants of industry—Boeing, Lockheed, Westinghouse and others, are urging us to support a full scale demonstration program before the facts are in. We are being asked to prematurely commit ourselves to what could be the greatest white elephant since the Spruce Goose—at the taxpayers' expense, of course. I urge you to look before you leap. Enclosed is a recently released article which will appear in the May issue of **Mother Jones.** I hope you will read it carefully. When you consider the solar power satellite, I hope you will see it for what it is—a gross perversion of our solar energy priorities.

Sincerely,
Richard C. Ottinger

HR 10601: FOCUS OF CONTROVERSY

by Carolyn Henson

What was in that article in **Mother Jones** magazine that Rep. Ottinger sent to all members of Congress? Highlights were brought out in a press release **Mother Jones** staffers handed out at the April 6 Sunsat Energy Council press conference. Following is the complete text of the release:

> *"Shuttling Manhattans to the Sky"*
> *By Adam Hochschild*
>
> The aerospace industry has finally found a way to cash in on the current popularity of solar energy—and the result may hit millions of us with deadly microwave radiation.
>
> Picture it, if you can: a vast rectangular metallic field, glistening brightly with reflected sunlight, in stationary orbit some 22,300 miles above the earth. It's called a Satellite Solar Power Station, and it's bigger than New York City.
>
> According to a peculiar array of bureaucrats, businessmen and dreamers, this and a hundred similar units will constitute a major solution to America's energy problems. If the backers have their way, a prototype Satellite Solar Power Station (SSPS) will be aloft within a decade.
>
> The SSPS is a major environmental rip-off of the 1980's:
>
> - one critic compares it to a "giant microwave oven cooking all people, plants and animals caught in the wandering beam"
> - the SSPS is a potentially lethal weapon: reaimed by a few degrees, the microwaves it generates could hit New York or Moscow instead of the receiving antenna
> - it would take each SSPS more than ten years to repay the earth for the energy necessary to build and launch it.
>
> Several hundred scientists and engineers are at work on the idea, the Department of Energy is now in the act, and some $12 million has already been spent on the SSPS. You're about to be asked to ante up several hundred billion dollars in tax money to pay for these giant microwave ovens in the sky. At the same time, the Carter Administration is cutting by some $10 million this country's already meager budget for earthbound solar research.
>
> **MOTHER JONES** editor Adam Hochschild is available for interviews.

What's going on here? Did the **L-5 News** miss a major issue by failing to see that an SPS can become a weapon merely by reaiming it? (Long term L-5 readers will remember a series of articles on the potential for using SPS to power space lasers for military use.) Not so, according to the supposed "critic" of SPS quoted by **Mother Jones.** Following is the statement attributed to him:

> • An SSPS is potentially a lethal weapon. One critic, Dr. Aden Meinel, Professor of Optical Sciences at the University of Arizona, compares it to a "giant microwave oven cooking all people, plants and animals caught by the wandering beam." You don't have to convert an SSPS into a weapon; it is a weapon already. All you have to do is re-aim it by a few degrees so that the microwaves hit New York or Moscow instead of the receiving antenna.
>
> —reprinted from "Shuttling Manhattans to the Sky" **Mother Jones,** May, 1978, pp. 39,40.

Dr. Meinel, upon hearing this quote, told the L-5 staff, "I sure don't recognize it." He added, If a hostile nation wanted to make it into a weapon they could. I see that as a reason for international control of SPS." Dr. Meinel added that he does not believe that the unmodified system as proposed by Dr. Glaser, however, could be used as a weapon or accidentally wander about cooking things.

How about the energy payback issue? All we can say at this point is that NASA studies indicate that ground launched SPS will pay back their energy cost in 3 years. This figure is in conflict with the **Mother Jones** figure, quoted from Dr. Piet Bos of the Electric Power Research Institute. Who is right? At this point the total research behind SPS is small enough that there is a great deal of uncertainty over its costs in terms of dollars, energy and the environment. Only a vigorous research program, such as proposed by HR 10601, the Solar Power Research, Development and Demonstration Act, can move these issues out of the range of disputes between experts and into the realm of facts.

Adam Hothschild, editor of **Mother Jones** *(circulation* 150,000) *and author of "Shuttling Manhattans to the Sky".*

The following was inserted into the April 6 Congressional Record *Extension of Remarks* by Rep. Richard L. Ottinger:

> • Mr. OTTINGER. Mr Speaker, this morning I attended a most amazing press conference. The likes of Boeing, Lockheed, Martin-Marietta, GE, Westinghouse, Southern California Edison, Grumman, and Arthur D. Little announced the formation of a new "non-profit" corporation to lobby for solar power satellites—the Sunsat Energy Council. The collusion of the high technology-space industrial complex in assuring full corporate socialism for the next 20 years, much like that which American taxpayers have provided for the last 20 years, should be ripe for the chutzpa-of-the-year award.

House Committee Calls for NASA Budget Increases

by Carolyn Henson

The House Science and Technology Committee has authorized the following NASA funding increases over Carter's Office of Management and Budget allowances:

$7 million for advanced programs (this includes space colony research funds)

$3 million for solar power satellite research (this is in addition to the funds—$25 million—called for in the Solar Power Satellite Research, Development and Demonstration Act, (HR 10601)

$3 million for large space structures and microwave transmission research

The Committee also approved funds to go ahead with a five shuttle orbiter fleet (OMB had only approved four). Current Carter Administration plans are to mothball the Enterprise without using it as a space vehicle.

In order for these increases to stick, several steps must be taken. The Senate Commerce Committee must also approve them. Then both the House and the Senate will vote on the NASA authorization. If it passes in both houses, then the next step is to appropriate the money. (In effect, authorization bills only set ceilings on how much money can be spent.) The House and Senate Appropriations Committees will hold hearings on the NASA budget and vote on it. After being voted out of committee the bills go to the full House and Senate for a vote.

What happens if the House and Senate pass different versions of the bill? A "conference committee" is formed from members of the House and Senate committees responsible for having reported out different versions of the bill. When they reach a compromise, this final version of the bill is sent back to the full House and Senate for a vote.

After passage, it will go to President Carter. If he chooses to veto the bill, Congress can pass it over his head with a 2/3 vote.

Another option the President has is to impound the funds. This was a favored tactic of President Nixon; however, Carter has been less inclined to oppose the will of Congress.

"High Frontier" Bill Update

Senator Harrison Williams' (D-NJ) "High Frontier" amendment to the National Science Foundation (NSF) authorization bill (S 2549) was introduced too late to be included in the House version of the NSF authorization, which had already been reported out of the Science and Technology Committee.

The "High Frontier" amendment calls for NSF to spend $1 million over a two year period to evaluate the construction of solar power satellites and other large manufactured assemblies" with a "High Frontier Program Feasibility Study." At the end of the study in 1980, the Director of NSF is to report to the President and Congress on "the advisability of adopting the development of the High Frontier as a national goal." Also, "At any time during the coarse of the study, the Director shall make recommendations to Congress as to whether accelerated funding should be provided for current and future research concerning the development of the High Frontier."

A conference committee between the Seante Human Resources Committee and the House Science and Technology Committee will be necessary in order to resolve the differences between the two NSF bills.

LIS

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Microwaves: SPS Hazard

by Eric Drexler

Publication of **The Zapping of America: Microwaves, Their Deadly Risk, and the Cover-Up** could zap the SPS. Written by Paul Brodeur (a **New Yorker** staff writer specializing in environmental and occupational medicine), it documents non-thermal effects of low-level microwave exposure. Since SPS advocates have consistently claimed that microwaves can only harm people by overheating them, the public may be somewhat upset to learn of experiments indicating neurological effects and **genetic damage** from supposedly safe levels of microwave exposure.

Since many people are already exposed to possibly hazardous levels of microwaves, concern over the effects is building rapidly. In a recent interview (see "Microwaves: The Ultimate Air Pollution," **New Times,** 6 March 1978), Paul Brodeur said: "This is becoming a big story .. . really taking off. Whoosh!" The battle lines are forming: citizens, researchers, and environmentalists vs. the military and industry. The motives: combating an invisible health-risk (whose reality some still debate) vs. protecting a massive vested interest in existing equipment and standards. Debate over microwave safety will surely increase over the coming year; it may well become a major national issue, just as nuclear power plants have.

The SPS cannot escape involvement in this debate. On first hearing of the SPS concept, virtually everyone worries a little about having millions of kilowatts of microwaves beamed at the Earth. Consider people's concern after hearing rumours of genetic damage from microwave, "radiation", and consider how that concern will intensify and spread as low-level microwave exposure becomes a national issue. The SPS could be shot to bits in the crossfire, and the bits could be hard to pick up for years afterwards — unless we take effective action, and take it now.

Microwave exposure could easily become a **very** emotional environmental issue and many people stand ready to distort such issues for their own ends. Consider nuclear power: Who would guess (from listening to nuclear power's opponents) that coal plants spread more radioactive material than nuclear plants do? Consider the SPS: Who doubts that our potential opponents would gladly "educate" the public—into thinking of the SPS as a giant death-ray machine in the sky?

We have a small advantage in the coming debate, but one which may prove decisive if used vigorously and early: The facts are on our side. Even assuming the worst about the effects of chronic, low-level microwave exposure, a properly designed SPS system remains the safest, cleanest means of power generation ever proposed. The problem is to convince the public of this before someone else convinces them of the opposite.

Many readers of the **L-5 News** write articles and give talks which touch on the SPS. I believe our strategy should be as follows:

1) Become familiar with the evidence for non-thermal microwave effects, and with the microwave issue as a whole.

2) At every opportunity, discuss the microwave issue and present a clear explanation of why the SPS is safe in this regard.

3) Take a leading role in informing the public about microwave hazards.

For strategy's sake, supporters of the SPS should accept the most gloomy interpretation of microwave hazards that remains scientifically credible. This will do two things: First, it gives us the most convincing position from which to defend the safety of the SPS; second, it will serve the public interest by helping to establish a concerned middle-ground in what could become a polarized debate. I urge the reader to read Mr. Brodeur's book or the article cited above before deciding what position to take in this matter. Certain government agencies have clear-cut motives for covering up evidence of microwave hazards, and Mr. Brodeur cites a mass of circumstantial evidence suggesting they have done so. This, of course, makes the story that much bigger.

We need to tell people that the SPS is a safe system, and we can no longer say "Since heating is the only effect microwaves have on biological tissue there would be no cumulative effect after repeated exposures" ("SPS: Near Future Energy Source?", **L-5 News**, February 1978). If we are to keep our credibility and block possible attack, we must have the right reasons and explain them clearly. The following shows one way of stating our case.

The SPS will have little environmental impact because it lies beyond the Earth's environment. Return of microwave power (which will be converted to ordinary electricity in the receiving antenna) will be its only major effect. Nevertheless, people may worry about being exposed to the microwaves in two different ways: the microwave beam wandering off the receiver to inhabited land, or the SPS broadcasting in directions outside the main beam.

Surprisingly enough, the first problem simply can't occur. The transmitter and receiver depend on each other: in particular, without the receiver to direct the beam, the transmitter would be unable to form any beam at all, much less a beam pointed in the wrong direction. If the system failed, all it could do is spray out a harmless signal, like a distant TV station. Even if someone tried to fool the system with an elaborate imitation receiver, the system would automatically shut off because of safety devices. And even if someone got into space, sabotaged the satellite's safety devices, built an elaborate imitation receiver, located it in a city without being detected and successfully misdirected the beam for a while, nothing spectacular would happen. The most intense beam that an SPS can form (without being totally rebuilt first) is less than one fifth the intensity of sunlight, and only twice the intensity of microwave exposure that the U.S. government presently regards as safe in workplaces. The SPS isn't very dangerous even if it is misused.

The same factors that prevent the SPS from producing a more intense beam also keep it from forming a beam with perfectly sharp edges. Therefore, fence would be built beyond the edge of the receiver to keep people from wandering into the low-intensity fringes of the beam. (Aircraft are shielded by their metal bodies, and shouldn't be in the beam in the first place.) Outside of the fence, microwave levels can be kept to Soviet exposure standards—a level considered safe around the world—if it becomes necessary to do so.

Some evidence suggests that long-term exposure to microwaves at intensities near the U.S. exposure standard (1,000 times the Soviet standard) may have effects resembling those of nuclear radiation, including genetic damage and increased risk of certain cancers. If so, the SPS remains safe, even though much equipment now in operation is hazardous. Still, since most people believe that all levels of nuclear radiation are harmful, we might wonder if **any** level of microwave exposure is completely safe. In discussing this, it will help to know what sort of thing we're talking about.

Microwaves are a form of radiation, but so are light and sound. None of these forms has much in common with nuclear radiation except that they radiate, or move out from a source. If made intense enough, all forms of radiation can damage people; consider the light from a laser or the sound from a rock concert. Most forms of radiation can be thought of as ripples moving through something: air in the case of sound, the electromagnetic field in the case of microwaves. When something absorbs these ripples, it gets jostled in some fashion. When these forms of radiation become very intense, the jostling can become destructive. Whey they become very weak, the jostling can become unnoticeable.

Nuclear radiation is different. Unlike other forms, it comes in small particles. Lowering the intensity of nuclear radiation does not make it qualitatively different, like weaker ripples: it just means that a person (or whatever) gets hit with fewer particles, each doing a certain amount of damage. For this reason, no **level** of exposure to nuclear radiation is completely without harm.

Because microwaves differ so greatly from nuclear radiation, we have every reason to believe experiments which show no adverse effect below a certain intensity. The waves simply become too gentle to harm anything in living cells. This is why the SPS can be made safe by making it meet strict enough standards. Before one is built, we will know far better just what those standards should be. The Russians are rumoured to be thinking that theirs are unnecessarily strict.

Some of you may have heard talks in which DOE spokesmen showed tables indicating that tremendous amounts of land would lie within the guard fences of a full-blown SPS system, if that system were made to meet strict standards of microwave exposure. Beware! As usual, figures don't lie but . . . DOE's figures refer to an irrelevant case, in which the system was not re-optimized to take account of the high land-cost of a comparatively sloppy beam. Since no one would build such a system, DOE's figures only serve to cloud the discussion. With a larger antenna in space, the SSPS can deliver a more sharply defined beam to the ground. See Drexler and Heppenheimer, **Journal of Energy,** June 1977 for discussion of a concept that may make better beam control quite cheap.

In summary, we have helped misinform the public on what may soon become a major issue. A system we support may soon be looked on as "obviously dangerous." Our best way out of this situation is to jump on the microwave-issue bandwagon and to help steer it, while vigorously publicizing the arguments for SPS safety. We have nothing to gain from delay.

Lunar Resources Study Underway

by Carolyn Henson

NASA has initiated a three part study on construction of large space structures from lunar materials (often called the "High Frontier" concept).

Edward Bock at General Dynamics Convair Division in San Diego is study manager of one part (if the program. He will consider the possibility of using mass drivers as mass driver reaction engines (MDRE) which operate kind of like a kid throwing bricks off a boat. As Newton said, for every action there is an equal and opposite reaction. Using this principle, the mass driver, first conceived as a means to lob lunar ores to a catcher in space, could also, in its MDRE form, be used as a "space tug." Bock will look into using lunar dirt, space industrial wastes and discarded parts (such as shuttle main fuel tanks) as reaction mass for the MDRE:. Also to be considered are chemical propulsion systems which might use lunar derived oxygen and calcium, magnesium or aluminum as fuel.

Bock's study group will also consider the value of the moon as a construction site and compare lunar vs. orbital manufacturing facilities. Finally, the study will evaluate what types and levels of space activities are needed to justify use of lunar materials.

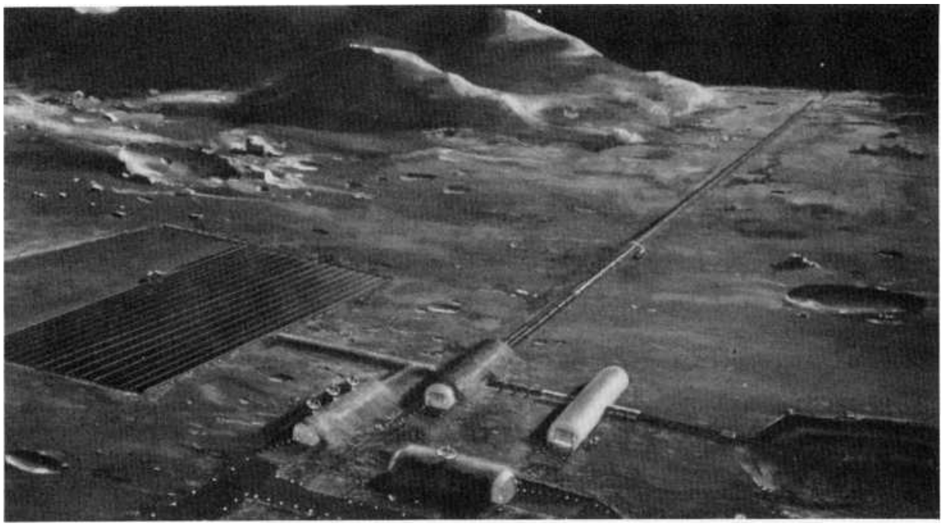
Richard Williams of NASA and Dave Criswell of the Lunar Science Institute in Houston will consider moon mining activities. They will consider what are the preferable ores and the equipment needed to mine them. They will study chemical processing of these ores, with special emphasis on producing aluminum, silicon and oxygen for construction of solar power satellites. Criswell acids that the theme emerging from their study is "On the basis of present and very near future term technologies, how small can we make the initial investments in a lunar supply base, chemical processing units and space manufacturing facilities and still create a rapidly growing economy in space?"

Over at Marshall Space Center in Huntsville, Alabama, Peenemunde veteran George von Tiesenhausen is managing a study of the production of alloys and fabrication of space structures from lunar derived resources. The equipment and facilities needed will be determined. The manufacture of glass fiber composites, radiation shielding, solar cells and other solar power satellite parts will be studied.

Von Tiesenhausen will consider what items should be imported from Earth vs. manufactured in space. Three different rates of space construction activities will be considered in determining the import vs. space manufacturing options. The first year of the study only space manufacturing will be considered; the second year lunar surface industries will be evaluated.

Von Tiesenhausen will be backed up by the materials processing lab at Marshall. He sees this study as "an outgrowth of the 1977 Ames Summer Study on Space Manufacturing Facilities."

The overall management of this three part lunar resources study is being conducted by Stan Sadin at NASA headquarters in Washington, D.C.



Lunar base (artwork courtesy Johnson Space Center).

Soviet Spacecraft Mysteries Intensify

by Jim Oberg

An incredible array of Soviet human-related space hardware is now appearing in the flight test stage. Observers are amazed at the number of different projects, just as they are baffled by the ultimate purpose of many of the test flights already observed. Whatever it will he, it will he big.

Somebody, five years ago, passed a book of blank checks to the Soviet space program directors. The payoff is imminent.

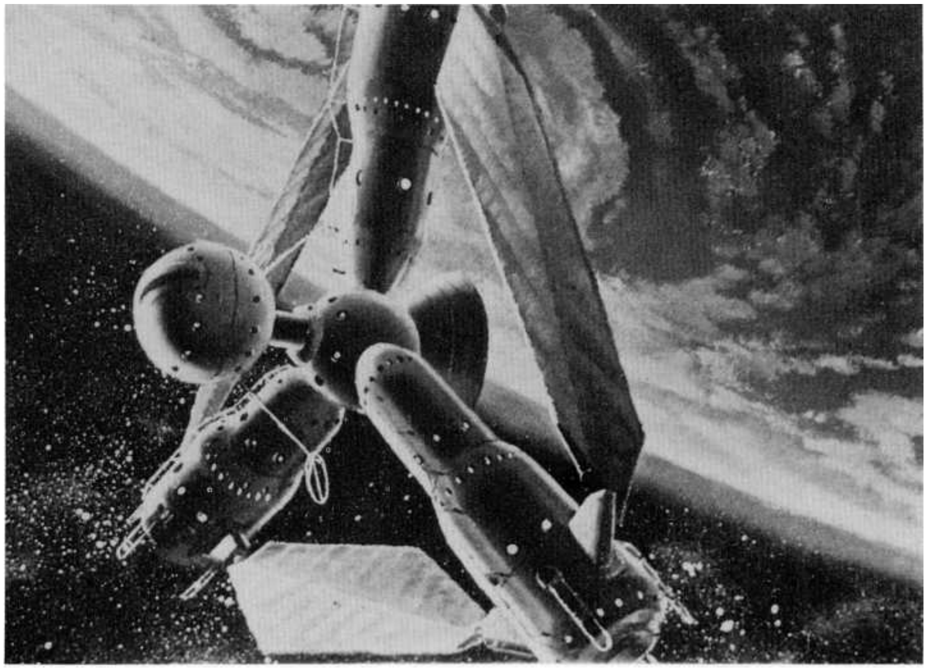
The impressive flight of Salyut-6 early in 1978 is only the tip of the iceberg, with its new-designed double docking ports, its use of new space suits, and the introduction of a major redesign of the Soyuz spaceship, called 'Progress,' for automatic docking and resupply/refueling.

In addition, four other 'families' of space hardware have appeared. Their mutual relationships, and their precise future goals and schedules, cannot yet be determined. The very fact of their existence, however, bespeaks a major new forward thrust in the Soviet space program, a thrust which has been quietly gathering momentum over the past few years.

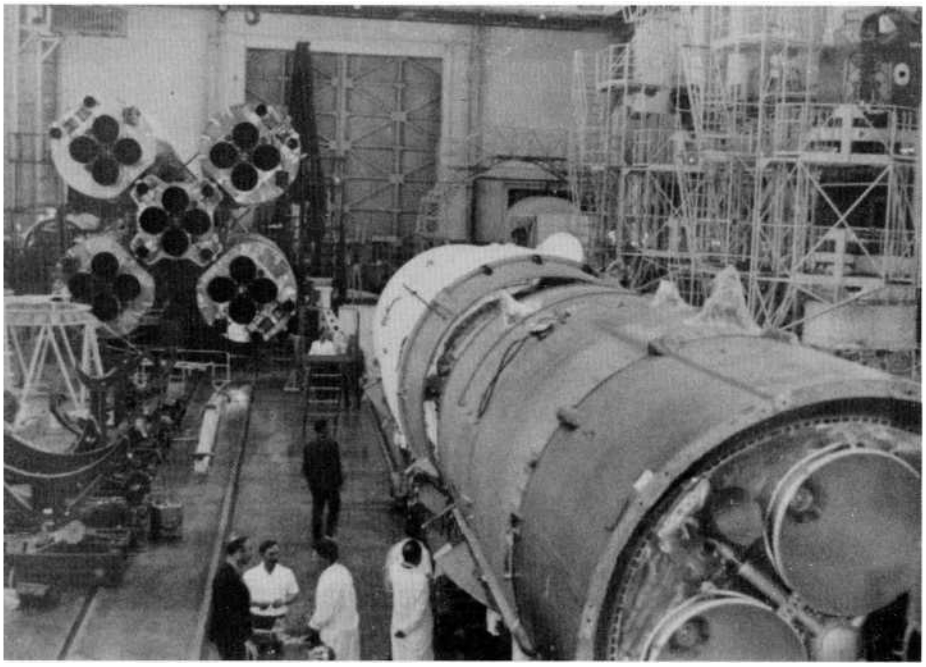
Kosmos-929: This one-member family flew two hundred days of major maneuvers in July 1977 - Feb. 1978, it weighed more than forty thousand pounds, carried large solar panels, and contained an impressive sized fuel tank. The best guess is that it was a 'space tug' (KOSMO-BUKSIR) designed to assemble Salyut-sized modules together into a modular space station.

We also have the Kosmos-758 family, five of which have been launched since September 5, 1975. This spacecraft circles the earth for up to 30 days on photo-reconnaissance missions out of the Plesetsk Cosmodrome. It is suspected to be a modified Soyuz spacecraft. It may soon replace the older-model Vostok-based photo satellites which the USSR has been launching at a rate of twenty to thirty per year for fifteen years.

The Kosmos-670 family, since August 1974, has seen four launches, the most recent being the Kosmos-1001 flight launched April 3, 1978. These seem to be



Front cover of Soviet weekly **Ogonyok,** *showing the assembly of a Salyut space station with two Soyuz spacecraft. (Photo courtesy of Theo Pirard.)*



Tyurotam —Leninsk Soyuz launch vehicle assembly area.

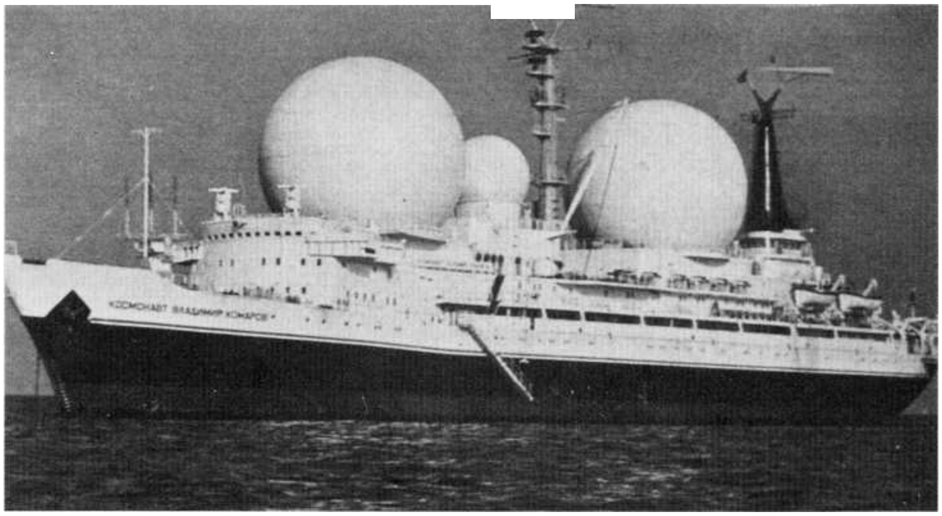
some sort of highly modified Soyuz capsule, perhaps to hold up to five cosmonauts. Piloted flights could come in the near future.

The Kosmos-881 family now consists of two twins, Kosmos-881 and 882, launched Dec. 15, 1976, and Kosmos-997 and 998, launched March 30, 1978. The twin payloads are probably launched on a Proton booster (capability, 40,000 lb. in low earth orbit), circle the earth once, and apparently independently make controlled reentries and landings at dawn in the Karaganda recovery zone. Nobody is sure what they are, but ideas about secret weapons tests have been abandoned. These big spaceships are definitely human-related, somehow.

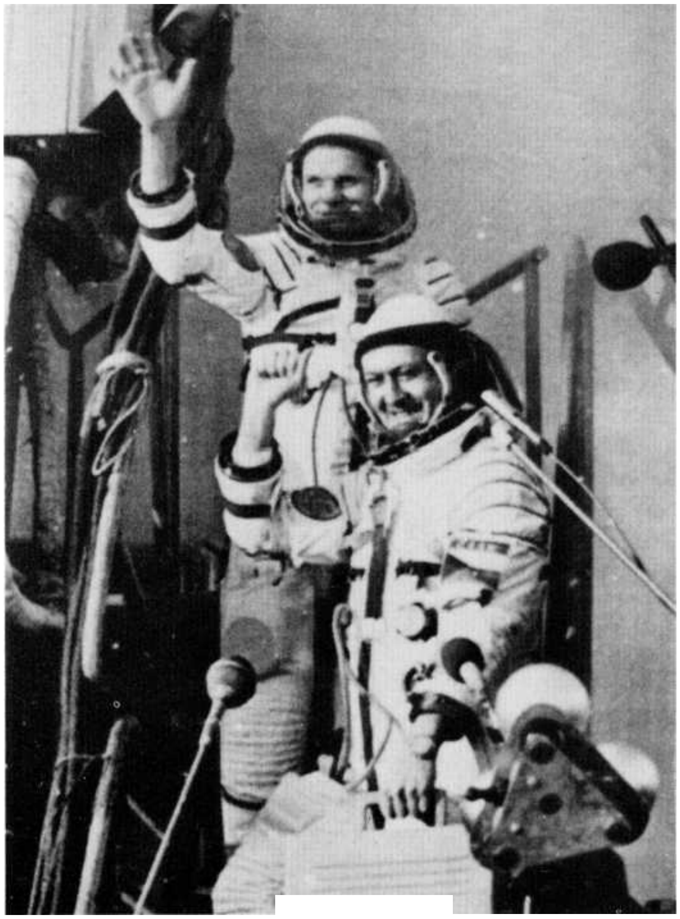
Lastly, there are more insistent and detailed reports of a Soviet Space Shuttle (perhaps called the ALBATROSS). The vehicle, we've been told by East European and Washington, D.C. sources, was dropped from a TU-95 bomber in the summer of 1977. It weighs between fifty thousand and a hundred twenty thousand pounds, and might be launched by an expendable Proton booster or by an entirely new reusable lower stage said to be under development. Orbital flight tests could take place as early as the summer of 1978, a full year ahead of the American space shuttle. It would carry large passenger groups of cosmonauts to a permanently inhabited space station, possibly to be established by the end of 1979.

The last time a new Soviet piloted spacecraft was undergoing flight tests was in 1966-1968, with Soyuz and Zond. Ten years have passed without any significantly new vehicles except the Salyut, introduced in 1971. *Something* might have been expected, but not *four different classes* of human-related spaceships! This stampede of Soviet spacecraft tests is a warning of something, even if we can't forecast it exactly.

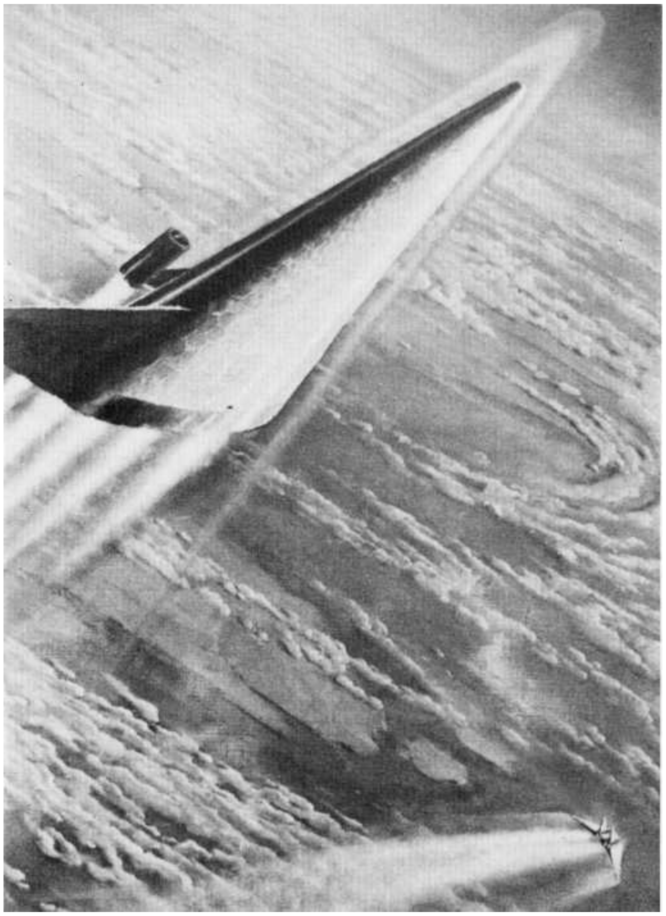
Salyut-6. Progress-1. Kosmos-929. Kosmos-758 and its brothers. Kosmos-670 and its kith and kin. The Kosmos-881 series twins. The ALBATROSS space shuttle and its new booster. The testing is getting more intense and more detailed, so we don't have long to wait. We've been alerted for . . . WHAT?



Soviet space research tracking vessel Kosmonaut Vladimir Komaro v.



The Soyuz 28 crew with Gubarev and the Czechoslovack Remek (see the flag on his left arm). (Photo courtesy of TASS.)



Soviet space shuttle (artwork by A. Sokolov).

Environmental Implications of SPS

by Peter Glaser

The social costs of environmental impacts of a solar power satellite power-generation system, including the opportunity costs of land used for launch sites and the aesthetic effects of such use, have to be established so that the benefits of each specific system approach can be weighed against potential dangers to human health, destruction of valued natural resources, and the intangible effects which may influence the quality of life. Failure to take these social costs into account could lead to substantial impediments to the development of the SSPS, as was proven in such major programs as supersonic transport aircraft and nuclear power.

The major social costs of environmental impacts of SSPS operations would lie in the following:

1) *resource allocations,* including land management, energy requirements during construction and operation, commitments of resources, etc.
2) *environmental degradation,* including waste heat disposal, interactions with the ionosphere and the upper atmosphere, environmental modifications noise generation, etc.
3) *public safety,* including long-term exposure under normal operations, disruptions in communications, accidents or abnormal situations, continuity of power generation and effects of interference with operations, etc.

The operation of the SSPS could produce environmental impacts, several of which involve a large degree of uncertainty and will require much more understanding before their effects can be reliably quantified. Each of these types is discussed in the following subsections.

A. Microwave Beam Environmental Effects [1]

1. Atmospheric Attenuation and Scattering: The atmospheric transmission efficiency of the microwave beam depends on meteorological conditions. Absorption by the atmosphere occurs when gaseous molecules with permanent dipole moments couple the electric or magnetic components of the microwave field to their rotational energy levels. Most of the absorption due to excitation of collision-broadened lines occurs at the 22-GHz line of water vapor and 60-GHz line of oxygen. Below 10 GHz the attenuation resulting from molecular absorption is approximately 0.1 dB or less, depending upon the microwave beam elevation angle.

Attenuation by rain, cloud droplets, snow, and hail will depend on their size, shape, and statistical distribution and composition. Rain, wet snow, melting precipitation and water-coated ice attenuation is low at frequencies below 3 GHz. The most severe condition is expected in rain clouds, where attenuation may reach 4 percent at 3 GHz. The attenuation produced by a 1-km path through wet hail could reach 13 percent at 3 GHz.

Forward scattering by rain and hail will increase the field intensity outside the main microwave beam. For example, a 5-GW SSPS operating at 3 GHz would scatter 3 mW nearly isotropically if the storm cell height is 1 km. At a range of 10 km, the scattered microwave beam power density would be about 2x10$^{-'}$ mW cm^{2}. Therefore, scattering by rain or hail is not expected to significantly increase sidelobe levels or broaden the main microwave bean.

2. Ionospheric Propagation: Among the several possible interactions of the microwave beam with the ionosphere are the following.

Ambient refraction of the microwave beam by the ionosphere— This effect leads to a negligible displacement. If gradients are present in the ionosphere, they could result in displacements (less than 100 m) of the microwave beam.

Ionospheric electron density irregularities—These self-induced or ambient irregularities will cause phase fluctuations (less than 10 degrees) across the wave front of the reference beam propagated from the center of the receiving antenna to the transmitting antenna face. Random phase variations will subside within a few hundred meters and within tens of seconds.

Power beam dispersion due to ionospheric density fluctuations will increase the field intensity at the beam edges by up to 30 percent. At low power densities, these fluctuations at the edges of the beam will not cause any significant power loss.

Experiments at Platteville, CO, and Arecibo, Puerto Rico, indicate that modest fluxes can produce significant changes in the thermal energy of the plasma in the `D' (A/60-90 km), E (A/90-150 km), and F (0·'150-340 km) regions. The direct effect on high-power microwave transmission with densities of 20-30 mW/cm^{2} is likely to be small, since the absorption at the 3-GHz frequency remains negligible, even with an order of magnitude increase in electron temperature and density. However, power densities greater than 100 mW/ cm^{2} could produce large horizontal electron density gradients that could cause significant beam displacement and dispersion.

Although only a small fraction of the microwave beam is absorbed, it is still significant compared to the natural thermal input to the ionosphere. For a 5-GW SSPS, about 0.2 mW/s is absorbed during the 50-s interval when thermal equilibrium is reached, which compares to a heat content of about 1 mW/s in the volume of the ionosphere traversed by the microwave beam. For an incident flux of 20 mW/ square cm, the ratio of the ohmic loss to the natural input due to photoelectrons and heat conduction in typical ionospheres ranges from 10 to 40 during the day and from 40 to 160 during the night. These significant changes in ionospheric properties will most likely be local and reversible, but they will have to be evaluated, particularly for continuous operation. A microwave flux of 100 mW/square cm could double the F-region's electron temperature and cause a 20- to 50-percent local reduction in electron density. Microwave heating in the D and E regions could increase the plasma density by about a factor of 4.

Given these considerations, it appears that microwave power densities above 20 mW/square cm could result in major changes in ionospheric properties. Microwave power densities greater than 20 mW /cm^{2} could be employed once more data on these interactions have been obtained in experiments conducted with Earth-based as well as space-based transmitting antennas.

Faraday rotation effects relating the total polarization twist of a linearly polarized wave to the total columnar electron content of the ionosphere under geomagnetically quiet conditions are projected to produce insignificant polarization losses. During geomagnetically disturbed periods—severe geomagnetic storms occur about three times a year—Faraday rotation and polarization loss is projected to be less than 1 percent.

The effects of changes in ionospheric electron density caused by microwave power densities of 20 mW/sq cm at the SSPS operating frequency will have to be investigated for possible effects on other uses of the ionosphere.

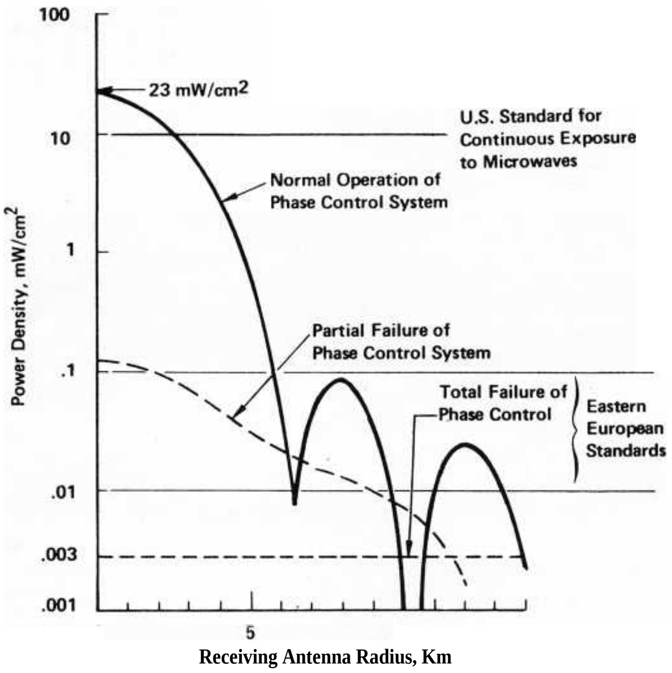


Fig. 10. Effects of phase control on microwave power distribution

B. Stratospheric Pollution by Space Vehicle Exhaust Products

The potentially harmful effects of supersonic and space transport exhaust in the stratosphere are receiving considerable attentions.

Injections of water vapor and NO (which are involved in the complex sequence of chemical reactions governing the abundance of ozone in the region from 20 to 35 km) are projected to result in a reduction of the mean abundance of ozone, although there is still uncertainty regarding the roles of each of these components [2]. The actual effects of any given rate of injection of either of these two components are difficult to determine because of uncertainties regarding the vertical and horizontal movements in the stratosphere which govern the rate at which they are injected, distributed and ultimately removed from it, the lack of experimental observations on space vehicle emissions, the composition of the stratosphere as a function of altitude, location over the surface of the globe, and the nature of the chemical and photochemical reactions which determine the abundance of chemical species involved in the ozone equilibrium. Because vertical mixing in the stratosphere is very slow (about 2 years at 20 km and 4 to 20 years at 50 km), and declines with increasing altitude, gases injected into the stratosphere will accumulate even at a low annual rate of injection and could yield a large equilibrium value at very high altitudes. (The region from 50 to 100 km contains only 0.1 percent of the total mass of the atmosphere.)

Although the chemistry of water vapor in the upper stratosphere has been studied, there is uncertainty regarding the possible consequences of incremental additions of water vapor. Water vapor is photodissociated to form radicals and molecules which will react with ozone and molecular and atomic oxygen. Furthermore, changes in the water vapor content could influence the natural flux of NO to the level of the ozone layer. Consequently, the effects of the space transportation system on water vapor injection, particularly in the upper stratosphere, require further investigation.

C. Microwave Biological Effects

At present, various standards for microwave exposure have been established, ranging from 10 mW/cm^2 for the United States to 0.01 mW/cm^2 for the Soviet Union. The U.S. standard is based on microwave heating of body tissue. The Soviet Union's standard is based on possible effects on the central nervous system, even at low exposure levels. The SSPS microwave transmission system must be designed so that the range of frequencies and microwave power flux densities will meet accepted international standards. The SSPS will incorporate several fail-safe features to assure control of microwave beam pointing and instantaneous shutoff of power to the microwave generators. Failure of the microwave beam-pointing system would not result in exceeding the international standards for microwave exposure (Fig. 10) Predictions, analyses and measurements of the SSPS's specific microwave-induced biological effects will be an essential component of the development program.

In addition to direct biological effects, interference with electronic equipment, medical instrumentation, and electric explosive devices must be avoided. Any sensitivity of such equipment to the low level of microwave exposure will have to be determined; if required, industry-wide standards will have to be established.

Possible effects, if any, on birds flying through the microwave beam will have to be established. Preliminary evidence indicates that birds can be affected at levels of microwave exposures greater than 25 mW cm^2 of radiation in the X-band. The evidence suggests that birds avoid such exposure.

The effects of microwave exposure on aircraft flying through the beam must also be considered. The shielding effects of the metal fuselage and the very short time of flight through the beam are unlikely to result in significant human exposure. The means for protecting aircraft fuel tanks from electrical discharges are now standard design features, but the absence of microwave-induced hazards will have to be confirmed. In addition, the extent of possible interference with aircraft communication and radar equipment will have to be established.

D. Radio Frequency Interference [3]

World-wide communications are based on internationally agreed upon and assigned frequencies. Because the frequency bands spanning the most desirable frequency of the SSPS are already in heavy use, the potential for RF interference (RFI) of the SSPS with existing communication systems is high. The microwave generators will have to be designed to filter out most spurious outputs. RFI could occur during the shutdown of the microwave generators or result from fundamental microwave frequencies and its harmonics, random background energy, and other superfluous signals. Although RFI can be controlled by the selection of frequency, narrow band operation, and use of filters, detailed and specific effects and impacts on radio astronomy, shipborne radar, and communication systems will have to be determined before the international acceptability of specific frequency allocations can be assured. The RFI effects and international agreements on frequency assignments are issues that will have to be faced at various stages during the SSPS development.

E. Other Impacts

The following summaries of environmental impacts are those where data are expected to be more readily available once system design parameters are established:

Thermal pollution—Waste heat released at the receiving antenna site could be limited to about 15 percent of the rectified microwave power, which is less than one-third the waste heat released from power generation methods based on thermodynamic cycles.

Land despoilment—The land requirement for the receiving site, from which the public would be excluded, could be limited to about 270 sq km. This compares favorably with land areas required for terrestrially based 5-GW solar-powered plants [4] of similar output (150 sq km for central receiver; 400 sq km for photovoltaic conversion without energy storage). The land could be developed to productive uses because only about one-third of it would be covered by the receiving antenna, which is a lightweight structure 80 percent transparent to sunlight and unobstructive to rain. Microwave radiation can be excluded from beneath the antenna, maintenance will be minimal, and transportation of supplies to the site will be infrequent compared to conventional power plants. Land use for transmission lines could be reduced if receiving antennas were located near major users. Offshore locations should be considered as alternative receiving antenna sites.

Resource consumption—Materials required for construction are limited largely to those which are in plentiful supply, such as silicon and aluminum. Each SSPS would require less than 2 percent of the yearly supply of critical. materials, such as platinum, available to the United States. Increased production capacity will be required for argon, oxygen, and silicon [4].

Energy consumption—The energy required to produce the materials for SSPS construction as well as the propellants to place it into orbit would be repaid—i.e., regenerated—in less than three years of SSPS operation, depending on the power delivered at the receiving antenna [4], [5].

Noise pollution—The noise from launch operations will be of concern in the immediate vicinity of the launch facility. Suitable location of the launches could reduce noise pollution to acceptable levels.

[1] Raytheon Company, "Microwave power transmission system studies," NASA CR-134886, ER-75-4368, Dec. 1975.

[2] M. I. Hoffert and H. Hidalgo, "Stratospheric impact: Two letters," *Astronaut. Aeronaut,.* vol. 14, no. 11, pp. 60-62, 1976.

[3] Arthur D. Little, Inc., "Feasibility study of a satellite solar power station," NASA CR-2357, NTIS N74-17784, Feb. 1974.

[4] NASA, Lyndon B. Johnson Space Center, "Initial technical, environmental and economic evaluation of space solar power concepts," JSC- 11568, Aug. 1976.

[5] G. H. Stevens and R. Schuh, "Space-to earth power transmission system," NASA Tech. Memo., Lewis Research Center, NASA TMX-73489, Nov. 1976.

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"Humanization of Space" Show

The Tessmann Planetarium in Santa Ana, California will present a show, "The Humanization of Space" at 7:30 PM May 9, 11, 16, 18, 23, 25, 30 and June 1, 6 and 8. Admission is free, but reservations are necessary. Please call the Office of Community Services, 835-3000, extension 317.

The Tuesday night programs will be geared for younger audiences (children under 14). Children under five will not be admitted.

Major Photovoltaic Program To Begin

A major applications program will get underway in June when DOE announces awards to design novel concentrating photovoltaic arrays. The awards are intended to stimulate innovative, reliable concentrating systems from private industry at gradually decreasing costs. A comparable solicitation for photovoltaic systems using flat-plate arrays is scheduled later this year. Both the concentrating and the flat-plate applications will be conducted in cycles over the next several years. For more information, contact: Department of Energy, Office of Public Affairs, 20 Massachusetts Avenue, N.W., Washington, DC 20545, 202-376-4064.

Meanwhile, a program to establish performance criteria and standards for photovoltaic equipment has begun. Still in the preliminary stages, the program involves the Solar Energy Research Institute (SERI), National Bureau of Standards (NBS), DOE and private industry representatives. For more information, contact: Gary Nuss, SERI, 303-234-7346.

Astronaut To Lead Site Visit Group

Dr. Philip K. Chapman, a former Apollo astronaut, has been chosen by the Earthport Project to head a group to identify the most attractive locations for the establishment of an international space launching area.

As head of the Site Choice Committee, Chapman will supervise initial screening of potential sites for Earthport, and then visits to areas for first-hand analysis. Recommendations by his committee will be presented to the Earthport advisory board upon conclusion of the site visits.

Among the considerations of Chapman's study group will be the latitudes, launch azimuth limits, accessibility, altitude, economic potential, geology, climate, proximity to oil or natural gas, and political conditions at the sites.

An Australian-born scientist, Chapman received a degree in physics in 1956 from Sydney University. After spending time in Antarctica upon graduating, he came to the United States for studies in physics, astronautics and aeronautics, and experimental astronomy. He received a PhD from MIT in 1967.

While at MIT, Chapman became interested in the possibility of creating a new international, equatorial launching facility. He helped prepare a proposal that New Ireland in the Pacific be considered as a world launch site at a time when the French government was moving to establish a national launch center near the equator in French Guiana.

Chapman became a scientist astronaut in 1967, and flew on the Apollo 14 mission in 1970. His responsibilities on the flight included crew training and coordination experimentation.

Since leaving NASA in 1972, Chapman has studied the feasibility of laser spacecraft propulsion for AVM, and Solar Power Satellite prospects for Arthur D. Little, Inc. He has been an active advisor to the Earthport project since early 1977.

Philip K. Chapman

Earthport Launch Site Proposal Draws International Response

With commercial launch providers at the verge of doubling in number within five years, a total of eight nations have so far expressed interest in the creation of a new international launching center for peaceful uses of space.

Five of the countries—Liberia, Sudan, Panama, Rwanda, and Sierra Leone—say they welcome the concept of an equatorial launching facility within their borders. The Earthport launch site would be established as an international free trade zone to generate income for space activities and for the host country.

Three other countries, Indonesia, the Cook Islands, and the Pacific island nation of Nauru, have requested further information about the project. Approaches are now under way to a variety of other nations near the equator, which has been chosen as the primary area for study because of the intrinsic economies of equatorial launch.

The study is being sponsored by the Sabre Foundation, a California-based public policy research group. Among the advisors are Dr. Nelson de Jesus Parada, director of the Brazilian space effort; Professor Marcel Barrere, president of the International Astronautical Federation; Buckminster Fuller, the noted designer and futurist; Frank J. Malina, cofounder of the Jet Propulsion Laboratory; and former Apollo astronaut Philip K. Chapman.

"We are very pleased with the interest of equatorial countries to date," said Mark Frazier, director of Earthport feasibility study. "As the commercial uses of space grow, we believe an international launching facility will help people around the world to enjoy the benefits."

Recent studies funded by the National Aeronautics and Space Administration, as well as by private groups, have described impressive commercial prospects in space for the next two decades. Present $2 billion-a-year communications satellite revenues are expected to multiply several times. Tens of billions of dollars may also be spent on solar-powered satellites, beaming an inexhaustible supply of energy to earth.

Increases in space activity promise to make launch economics important in the future. In contrast to ranges at higher latitudes, an equatorial site could offer several inherent advantages for launch into orbit:

- *Additional momentum for launch vehicles.* At the equator, the spin of the earth amounts to almost 1000 miles an hour in an easterly direction. Satellite launches into equatorial orbit from low latitudes thus are more efficient than from other locations, where the boosters have less momentum from the earth's rotation.
- *Simplified orbital paths.* To enter an equatorial orbital plane, most satellites now launched must make wasteful "dogleg" maneuvers. An equatorial launch site can render doglegging unnecessary, and simplify landing procedure. A launch area near the equator, moreover, permits insertion of a satellite into any orbital plane with relative ease.
- *More frequent "windows."* Because satellites launched from the equator can pass overhead on each circuit, launch opportunities open up with each orbit for a minimum energy/fuel rendezvous. If a space vehicle in equatorial orbit is to return to earth, landing procedures are simplified by the recovery site's position in the orbital plane.

These benefits have already been instrumental in persuading two commercial launch organizations to establish equatorial sites. A private West German company, OTRAG, has spent approximately $30 million to date to develop a range in Zaire, which is scheduled to become fully operational within three years. The European Space Agency will begin offering launch services by 1980 from a base in Kourou, French Guiana. In addition to these sites, equatorial for suborbital "sounding" rockets—used for atmospheric tests—exist in Kenya and India. An Earthport might be established at one of these existing locations, or at an area yet to be determined.

Earthport researchers believe that the international status of the spaceport would help to further reduce cost barriers for launches. Rather than having to build duplicative facilities near the equator, launch organizations in the future could benefit from the savings of shared ground support services at Earthport.

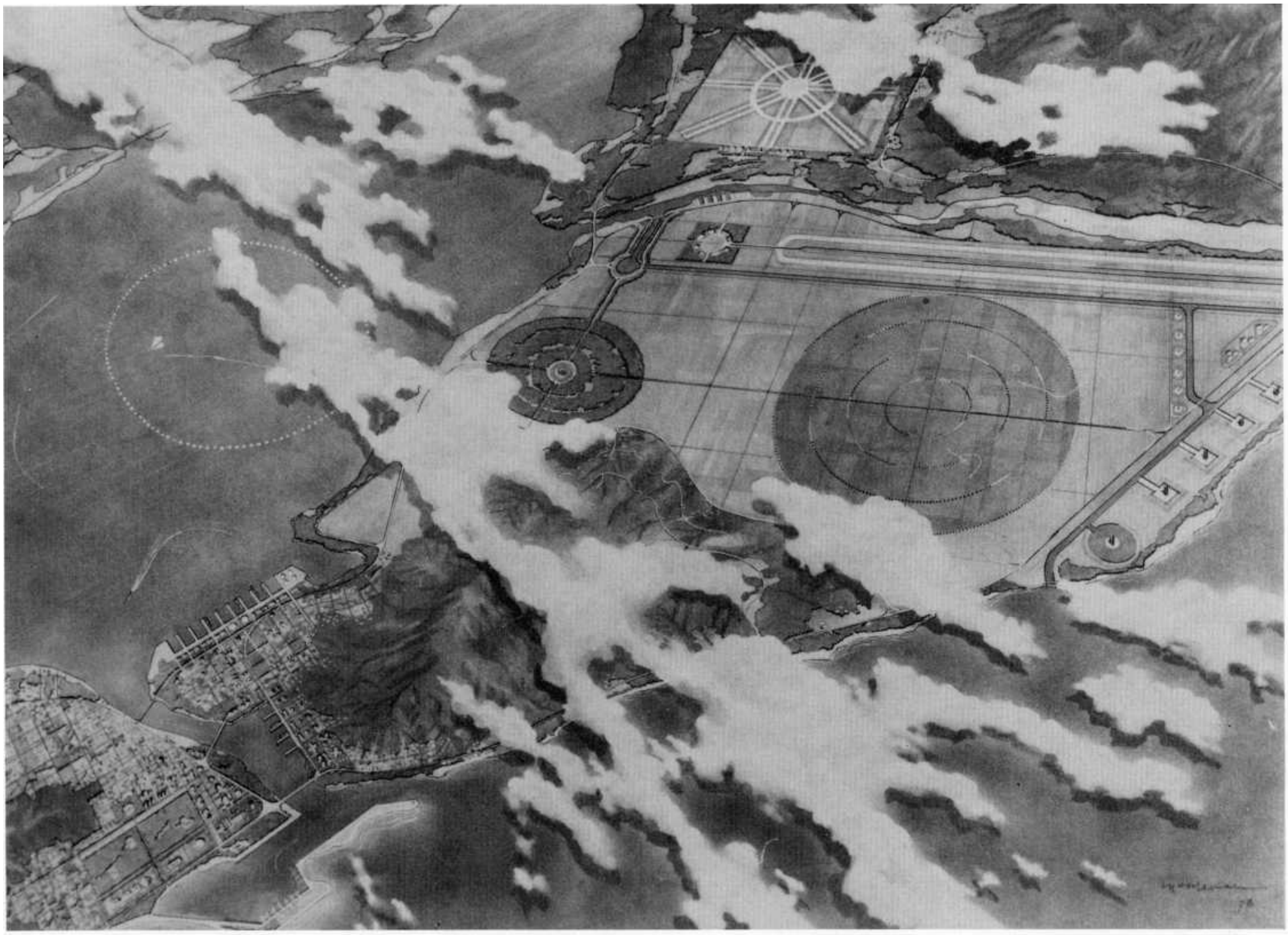
To draw in a range of investment and build an economic infrastructure at the site, Earthport is planned as an international free trade zone of approximately 200 square miles. The host country would retain sovereignty and ownership over the zone, leasing it to an international Earthport Authority for administration. Exempting commercial activities at the site from tariffs and taxes would raise land values substantially, to the point where annual lease revenues could generate large sums for launch services and for the host country. Some developing nations, offering limited exemptions to commercial users, now reap from $2-4 million in rentals per square mile each year at free zones.

A portion of Earthport leasing income would be set aside to finance a World Space Center, which would help developing nations make greater use of space services. Besides offering independent consulting services to nations on technical issues in the short run, the Center might establish a network of training centers for nations desiring to acquire space-related skills. An international research institute, a space resources clearinghouse, and a fund to help finance launch activities would also be desirable.

As an area in which nations could conduct space efforts at substantial savings, Earthport might play a role in reducing the proliferation of potential weapons delivery systems within countries. In coming years, nations will increasingly desire to begin launch programs of their own. Cost savings at Earthport could help persuade them to undertake peaceful space activities at a world site, rather than to attempt establishing far more expensive launch operations within their borders, where they would invite use for military ends.

The degree of investment in Earthport launch facilities would be decided by space-going organizations leasing land at the site. While rudimentary launch facilities can be constructed at low cost for suborbital rockets—and for launchers such as the OTRAG vehicle or Boeing's original, now demilitarized, Minutemen boosters—a full-scale space launch site would cost far more. Earthport leasing revenues might be applied towards some of the capital requirements, estimated by launch consultant Richard Gompertz to be at least $200 million.

For the first stage in creating a world spaceport, the Earthport project is conducting a feasibility study under the guidance of an international advisory board. Any developing nations may appoint representatives to the project to see that their interests are presented. If located in tropical regions, nations may also decide to explore, as eight countries are now doing, the potential benefits of hosting an international space launch center.



Proposed Earthport launch facilities and free trade zone (Artwork copyright Earthport Project).

Further information about the Earthport project and related developments is available upon request from the Sabre Foundation. Please write or call Mark Frazier, Earthport Project, 221 West Carrillo Street, Santa Barbara, California 93101; telephone 805/965-7947 or 7166.

Student Programs Called For

In testifying before a Congressional committee on the National Aeronautics and Space Administration's (NASA) budget for Fiscal year 1979, the Forum for the Advancement of Students in Science and Technology (FASST) recommended that steps be taken to develop new educational initiatives for students to participate in the national space program.

In presenting testimony, requested by the Senate Subcommittee on Science, Technology, and Space, FASST recommended that the NASA budget include funding for programs such as student internships for the various space projects.

"Programs such as the Space Telescope, the Jupiter Orbiter Probe, Galileo, and numerous Earth application satellites could all include active intern programs, and should be looked upon as valuable new educational tools," commented Leonard David, Program Director of FASST. "Monies for these activities would be included as line items within the budget of the specific space projects," David suggested.

Present to hear the FASST testimony were Senators Adlai Stevenson (D-Ill) and Harrison Schmitt (R-N.M.). Senator Stevenson thanked FASST for its testimony and indicated that he was definitely interested in pursuing the area of student programs with NASA officials.

Other recommendations presented by FASST included:

- urging NASA to develop an expanded student space experiments program, involving both the Spacelab, the Long Duration Exposure Facility (LDEF), and the $10,000 "Getaway Special;"
- creating a focal point within the space agency for developing student involvement programs, particularly for the undergraduate;
- re-evaluating current NASA offices for University Affairs and Educational Programs in regards to how they interact with the college/university student. It was specifically recommended that the budget for the Office of Educational Programs be increased and removed from the division of Public Affairs.
- requesting the Sub-Committee to investigate and identify new sources of funding for student programs from agencies such as the Office of Education at the Department of Health, Education and Welfare, and the National Science Foundation;
- using student programs at NASA to serve as models for student involvement with other government agencies; and
- consulting with the program directors of the student divisions of other science societies for their ideas on possible student programs.

Inside the L-5 Society

Melbourne L-5

Florida Institute of Technology of Melbourne, Florida has formed a local chapter of the L-5 Society. About 20 people attended their first meeting on April 17th and the closeness of the Kennedy Space Center should invite some interesting speakers in the upcoming months.

President is Michael Dalton; vice-president is Maurice McDonald and elections for treasurer and secretary will be made soon. If you are interested in our group, please contact Mike Dalton, CB 6359 F.I.T., Melbourne, FL 32901.

Raleigh L-5

I am pleased to announce that as of this date, a new student organization officially exists in Raleigh—The North Carolina State University L-5 Society. We received a letter of recognition today from the NCSU Department of Student Development. As a campus organization, we now have access to equipment, and facilities of NCSU. We now have eleven official members, and some twenty people actively involved in the promotion of settlement, development, and exploration in outer space. We have a good chance of being featured in an article in the NCSU student newspaper, which we hope will attract more members.

Although we are just getting ourselves organized, we have been as active as possible. We produced a flyer describing the advantages of Solar Satellite Power Stations, which we distributed at a rally in opposition to the construction of the Shearon Harris nuclear power plant near here. We are preparing an exhibit on solar power from space, which we will present on May 3, as part of the worldwide SUN-DAY effort to promote the development of solar power. We also have established as a long range goal the creation of a small library of information on space colonization, development and exploration. We have set up a checking account, which presently contains the meager sum of $50, which we got as a speaker's fee for lecturing on space colonization at one of NCSU's dormitories.

"Spaceworks" Action

The Spaceworks: An L-5 Society is busy at the Auroria Higher Education Center in Denver, Colorado. They have made presentations on radio talk shows and organized eight discussions and lectures on topics related to the settlement of space.

Spaceworks is currently sponsoring a series of discussions every Wednesday at 7:15 p.m. in the Auroria Student Center. Room location varies, and is posted weekly.

For more information, contact Robert Topple, 1930 Quince St., Denver, CO 80020 or Mark Corske, 3286 S. Oneida Way, Denver. CO 80224.

Mills High School Space Workshop

Mills High School, in Millbrae, California, will present "What's Up", a workshop on aviation/aerospace activities June 2 and 3.

Activities on Friday, June 2, will last for six hours, beginning with an all school assembly in the morning. Students will then be able to participate in off campus tours of NASA Ames Research Center and San Francisco International Airport facilities, and attend on-campus seminars and lectures. Suggested seminar topics include the History of Aviation, Women in Space, Space Settlements and Industrialization, Astronomy, UFO's, Space Phenomena, Aerospace related industry, commercial aviation, military aviation, and past and future space experimental projects such as the Viking Mars probes and the Space Shuttle.

In the afternoon, student participants can observe exhibits, demonstrations and displays, possibly including aircraft brought on campus, hot-air balloons and helicopter demonstrations.

On the following day, Saturday, June 3, substantial portions of the program will be repeated for the community and for visiting students from all over the Bay Area.

For more information, call Steven Finacom, 415/697-3344 or write to him at Mills High School, 400 Murchison Drive, Millbrae, CA 94030.

Earthrise Synergy Coalition News

I wish to personally apologise to all coalition members who have written and not received a reply. Medical problems have kept me from coalition duties. With the completion of Project Moon Base, the Earthrise Synergy Coalition will officially shut down. Many thanks to all those who have contributed so much to coalition activities and especially to Dr. L.J. Friesen and James Bennet.

Sincerely,
S.A. Varughese

L-5 Society Local Chapters

Williamsburg L-5
Box 1795
Williamsburg, Virginia 23185
Clint Wolf (Executive Director)

Mississippi L-5
c/o Robert D. McWilliams (President)
Box 5563
University, Mississippi 38677

Austin L-5
University of Texas, Austin
P.O. Box 8213
Austin. TX 78712

Houston L-5
c/o Larry Friesen
(Committee Coordinator)
502 South Austin #17
Webster, Texas 77598

John Muir High School L-5
1905 Lincoln Ave., Pasadena, CA 91103
Taylor Dark III (President)

Huntsville Texas L-5
c/o George Timothy Bigham (Pres)
Route 2 Box 82
Huntsville, TX 77340

Maryland L-5
(Maryland Alliance for Space Colonization)
M.A.S.C.
c/o Gary Barnhard
4323 East-West Highway
Bethesda, MD 20742
Ray Hoover (Chairman)

Michigan L-5
Box 126
Michigan Union
Ann Arbor, Michigan 18109
John Beckerman (Chairman)

Raleigh L-5
P.O. Box 5381
Raleigh, NC 27607

Urbana L-5
co Steve Vetter (Pres.)
167 Townsend,
Urbana, Ill. 61801

Space Colony Speaker Needed

If you live near Las Cruces, New Mexico and would like to give a presentation on space colonies to a high school group, please contact Sunny Wilde, NASA White Sands, P.O. Drawer MM, Las Cruces, NM 88001.

Letters

Did you see the item in Aviation Week (April 10, 1978, p. 11) in their Washington Roundup section? There was a resolution introduced in the House by 23 Democratic congressmen "urging President Jimmy Carter to ban the use of all nuclear material in all space vehicles." I realize that this is outside the normal L-5 area, but the effects of this could be disastrous to future space missions—especially deep-space probes. The principal sponsors of the resolution are Reps. Richard L. Ottinger (D-NY) and John F. Seiberling (D-Ohio).

Tarzana, CA

More than 2/3 of Detroiters approve of space colonization. In a Detroit Free Press Sound Off survey 70.9% of those polled responded that they would be willing to live in an outer space city. This should prove the wide public support O'Neill's work has gained, Darth Proxmire take heed.

Michael G. Strong
Swartz Creek, MI

Having just received my first issue of L-5 News, I realized that the L-5 Society is unaware of a certain method of communicating and popularizing the goals of L-5. A radio campaign.

Sound expensive? Not at all, when you consider a very important fact: L-5 IS A NON-PROFIT ORGANIZATION! All non-profit organizations are entitled (in a sense) to what amounts to free publicity. Free publicity in the form of Public Service Announcements.

I am Production Manager of KPAR-AM/FM of Albuquerque, New Mexico, and I can assure you that PSA's are a long standing tradition in radio. And they are FREE! The Determining Factor as to how much a particular PSA is to be aired is how well it is written (readability, length, etc.) Substance comes second. Another factor is station prejudice of the nature of the organization. As long as we physically and verbally present ourselves in a positive light, this prejudice should work in our favor. Most of the people I know in media, management included, are very much in favor of the exploration of space.

In the March '78 issue of L-5 News, Richard Bowers spoke of buying ads in local newspapers. Hate to tell you folks, but newspapers are dying right and left (or changing drastically). One of the reasons is special interest magazines, L-5 News being just one example. So let's stick with radio PSA's, local newsletters, special interest magazines, billboard announcements, and TV when we can get a hold of it.

Now, how to write a PSA? First of all, have everything completed at least 2 weeks beforehand. Stations need LEAD TIME. Now here's your formula. The local chapter of the L-5 Society is having a meeting on (date). Speaker-presentation will be ____________. The meeting will be held at (address) and LOCATION !............. corner of Springfield and Sproul road.......... I cannot emphasize location enough! Then tag it, twice if possible, with a phone number for further information. Make sure it's a phone that is going to be covered day and night by an informed person.

Your PSA's should be timed out to 10 sec. and 30 sec., no longer. Here's a rough example of a short, simple, PSA using information culled from Richard Bower's letter:

"THE L-5 SOCIETY, AN ORGANIZATION DEDICATED TO ACQUIRING CHEAP, LIMITLESS ENERGY FROM SOLAR POWER SATELLITES, WILL BE HAVING A MEETING ON SATURDAY, APRIL 1ST AT 2 PM. THERE WILL BE A LECTURE, SLIDE SHOW, AND FILM ON SPACE COLONIES. THE MEETING WILL BE HELD AT THE MAPLE TOWNSHIP LIBRARY AT THE CORNER OF SPRINGFIELD AND SPROUL ROAD, IN BROOMALL, PENN. CALL 739-7780 FOR FURTHER INFORMATION.

Notice that the PSA is typed in capital letters and triple spaced. It's little things like this that help get it on the air. You might then type it out on a small index card, also. You can mail these, (make sure you have everyone's correct, up-to-date address), or you can deliver them to the station in person. Personally, I recommend hand delivery. Look and act your best, even if the front office secretary isn't very receptive. People make judgements on clothing, so look sharp. Ask that the written materials be forwarded to the person in charge of PSA's. Ask for both the news director and public affairs director. Chances are, one or both might talk to you right then. If not, arrange an exchange of phone numbers and names. Something should come of it, since American society seems to be riding on a crest of interest in space, due to such movies as "Star Wars" and "Close Encounters", so anything having to do with space can be very interesting to the listening audience, therefore, from the station's point of view, newsworthy. I realize that L-5 is far more of a serious thing than the celluloid pulp of George Lucas, but we can still take advantage of the interest in space that he has generated.

Remember that mass communication is not so much a magnifying glass as a massive prism, multiplying an act of communication hundreds of thousands of times. In closing, I must stress that your publicity campaign must be done right or not at all. It can be a tightrope. If you've tried to do something along these lines, and it failed, write to me and tell me what happened. I may be able to detect mistakes that only the broadcast-minded would see. I'll be happy to answer any questions you have, and supply you with needed tactical/strategic information.

Space colonization, especially in light of recent budget developments, is in sore need of many quantum leaps in the way of popularization. Let's go together.

Allen H. Ward
124 Harvard SE, Apt 21
Albuquerque, N.M., 87106

In a recent issue of the L-5 News, a letter writer raised the issue of interior deterioration of colonies. And in the current (April 1978) **Scientific American** there's a possible solution: Metallic Glasses.

A fairly new material, still experimental in application, metallic glasses are alloys (notably iron and boron) that solidify into glasses before they freeze into metals. (See the article in Science and the Citizen for further details on freezing/glass-solidifying).

To quote the article, "Glassy metals can exhibit very high tensile strengths even in bulk materials, and the strength is comparatively (to crystalline metals) insensitive to small imperfections. This combination of qualities gives the amorphous metals a toughness that may lead to applications as structural materials."

The manufacture of glassy metals requires rapid cooling—as fast as 10MC°/sec. Like many electronic components, these metals require a costly, difficult-to-maintain environment that is extant in space.

There's more in the article, but as you said, brevity is the soul of getting a letter published in **L-5 News**. I only mean this to be a tip-off. A lot more research needs to be done in metallic glasses, but by 1995, they may be right where we need them.

Luke McGuff
Chicago, IL

Michael Mautner's point concerning corrosion in the January letters section is very important. I have had personal experience with the failure of galvanized steel water pipes in various soils. In one case, the failure took place in less than five years. It would be bad for the space colonization business to have a habitat explode in so short a time.

The solution is to have the metallic interior of the habitat urethane coated before the soil is layed down. Urethane coatings are quite inert chemically and adhere very strongly. A coating twenty mils thick would probably be sufficient to prolong the life of the habitat indefinitely.

George Fredericks
Colorado Springs, CO

Is anyone out there a structural engineer — or an architect? Someone who has some spare time and is willing to correspond would be appreciated. I am currently looking into some alternate designs for SMFs and just want an expert's opinion on a few things. In addition, anyone who thinks he has some pertinent information on the history of space exploration and exploitation, I would appreciate being able to use such information for a thesis I am working on in which I will attempt to argue for the creation of a new history class.

I am a cadet at the United States Air Force Academy; I am planning on majoring in Astronautical Engineering and minoring in Computer Science; and I have an interest in anything that tends to broaden one's horizons. If you just want to write a friendly letter, feel free; I could use the insights that many different opinions could give me.

Cadet Lyle M. Miller, Jr.
P.O. Box 5431
USAFA, Colo. 80841

Incidentally, I just finished the Heppenheimer book and I get the feeling that a split is developing between advocates of different types of space structures. This is very disappointing since we haven't even gotten off the ground yet. I feel myself being drawn to an "O'Neill position" due to Hep's inability to consider other viewpoints than his own. This unfortunate lack of imagination is greatly in evidence by his persistence in writing in what can best be described as a "predictive" mode and tending to dismiss other alternatives without giving the reader many hard facts with which the reader may arrive independently at his or her own conclusions. At least O'Neill seems to be doing this. I strongly suggest that in order to convince the millions of people that eventually are going to pay for all this, we use our imaginations to the limit to provide as many cost-effective alternatives as possible. We must remember that space is an entirely new environment and .is not subject to our "planetary bias".

Gary D. Miloglav
Piedmont, CA

There is much thought given now to the exploitation of the moon, but what about her protection? Future generations may well look upon us as oafs, if our first order of business is to take our lunabuggies and moondozers to the lunar landscape, destroying the very ancient and fragile lunar features. Even footprints last a long time on the moon! Unmarred lunar surface could become extinct in fifty years.

We need to develop a system that will make us preserve the majesty of the moon, and yet yield to us some of her metal, that we may fly amongst the stars. The lunar surface needs to be explored such that rare or beautiful features can be protected from the makers of quick bucks and aimless vandals.

Mars also presents us with the dilemma of exploitation and preservation, though the God of War may hold greater surprise defenses against our lust than airless Diana.

Taras Kiceniuk, Jr.
Palomar Mountain, CA

Here's a little item that might be of interest to the readers of **L-5 News**: Columbia Records is considering releasing the records of the Voyager ships, and letters might help them make that decision.

The person to address is:
Rick Smith
Vice President of Business Development
Columbia Records
51 W. 52nd St.
NY, NY 10010

I've already written him a letter, and another one addressed to the editor of Karass, a fannish newszine. In the letter to Mr. Smith I suggested that Columbia donate proceeds to the L-5 Society. Carl Sagan has proposed that they donate funds to an extraterrestrial research group (which they are considering), and the L-5 Society seems to fit the bill perfectly. It wouldn't hurt to suggest the people one thinks would be interested in buying the record, and if the writer would promise to buy one.

Luke McGuff
Chicago, II

Being a relatively young member of the L-5 Society, excited by the new ideas and concepts now being established concerning the future of space industrialization, I find the "**L-5 News**" highly informative and intellectually stimulating. Because "**L-5 News**" is a magazine of this caliber I expected you would refrain from utilizing outdated stereotypes as a method for communicating ideas. I am specifically to your statement in the January issue in "Notes from he Editor", page 19. I quote you, "You may think Joe Blow in Arkansas has fascinating thoughts about space colonies, but we can't justify spending $400 on typesetting and printing so that Society members can hear about them."

Your implication that someone's ideas are irrelevant simply because he is from a particular territorial region, whether that region is a city, state, or country, is backwardly medieval, as well as provoking. The stereotyping of Arkansans as all "hicks and hillbillies" (quotes mine) is a completely erroneous belief encouraged by statements not unlike your own

Although I still regard "**L-5 News**" an informative source of current events in, and possibilities of, the space program, and intend to continue my membership "til death do we part", it would be appreciated if you would refrain from using stereotyping (whether it be about Arkansans or not) to convey your messages.

Thomas Taylor
Smackover, AR

We can't justify spending $400 to convey the opinions of Joe Blow in Los Angeles, either! My apologies to the state of Arkansas — C.H.

The two recent articles by Phill Parker (March, 1978, pp. 10, 11) illustrate the commitment of the Soviet Union to establish permanent, inhabited space facilities. This commitment appears to be even stronger than Phill indicated. According to **Aviation Week and Space Technology** (March 20, 1978, pp. 14, 15), the Soviet Union has already built a delta-winged, reusable, piloted space vehicle as the initial step in providing Russia with its own space shuttle capability. AW&ST reports that a space shuttle test vehicle has been drop-tested from a Tupolev Tu-95

Bear bomber to determine the aerodynamic and pilot handling qualities of the space craft. These tests are similar to those recently completed for the U.S. space shuttle orbiter.

This new Soviet program is significant because it indicates that the USSR believes it has the technology in hand to tackle the major engineering challenges involved in building reusable piloted spacecraft. Such a vehicle would provide cost savings and significant new capability to the expanding Soviet space program.

Obviously, a Soviet shuttle has serious implications for the U.S. utilization of space. Unfortunately, U.S. government leaders continue to ignore the Soviet Union's manifest intentions to exploit space, both for military and propaganda purposes. Thus, the U.S. "hare," while capable of great speed, dawdles, while the Soviet "tortoise" plods stolidly along. In the fable, the tortoise won the race. Will the "hare" lose again?

Richard Stutzke
Colorado Springs, CO

The existing situation in Washington is mixed: although many in Congress favor an expanded space program, the Carter administration does not. Also, since Carter wants to cut federal spending to whip inflation he may use this as an excuse to keep NASA funding at a low level.

In light of this, should we perhaps begin writing to the President in time to influence his decision on the FY '80 budget request? Of course, with the present mindset in the White House this may be a hopeless task. What do you think?

Concerning future lobbying activities: it's now or never for a Halley's Comet rendezvous/fly-by mission. If funding does not begin in FY '80, forget it. Until then, however, this program should be top priority.

Aside from this particular mission, with its tight launch window, our continuing number-one priority should be a permanent manned space station. We could, with some justification, press for a "space race" with the Soviet Union, lest they get a head start in the third industrial revolution.

A PMSS would: 1. provide a platform for long-term experiments, observations and manufacturing that could make space truly profitable; 2. be necessary for any future operation, as a base for construction of SPS, return to the moon, deep space probes, etc., and; 3. unlike one-shot spectaculars, provide continuing benefits and focus attention on space industrialization-colonization. (If Kennedy had called for a space station rather than a moon landing, we'd still be there, and still on the moon too.)

Well, what do you think? I think a space station will make space colonies inevitable.

Robert Lovell
Shawnee, KS

The following comments are submitted for use as either an article or letter.

I recently completed reading Heppenheimer's Colonies **in Space.** This book, as does other literature promoted by the L-5 Society, makes a convincing argument for space satellite construction based upon benefits to be derived. Unfortunately, the fact that a project is beneficial is often insufficient to gain the support sought from governmental decision makers.

There is another side to the coin which has not been articulated. The undesirable economic and political realities of the "do nothing syndrome." The United States has an unemployment rate which has held around six percent for several years. It is substantially higher among blacks and others than white males. Unless a four to six percent economic growth rate is maintained it will be impossible to keep all the people now employed at work.

Unless economic growth can be stimulated not only will the traditionally unemployed be unable to enter the paid workforce but there will be no room for new entrants, i.e., vocationally or academically trained blacks, women and other non-insiders. It is also inconceivable that the shrinking employed class will agree to ever larger transfer payments to underwrite the costs of living of an ever increasing welfare class.

Growth in a modern industrial-commercial economy is energy intensive. There is also the competing demand of third world nations for a standard of living favorably comparable to the American standard. The President has argued, in support of his energy program, that at some future date the fossil fuel producers will not be able to meet these combined demands for energy. Although the President's time table is suspect, the prophecy seems valid.

Another factor to be considered is the unfavorable U.S. international balance of payments due largely to the fact that the U.S. is on balance an importer nation, and will most likely remain so in the immediate future. If the claimed returns on investment in a solar power space satellite program can be realized, the U.S. could become an energy exporter and the aforementioned problems could become manageable.

E. Gordon Young
Madison, WI

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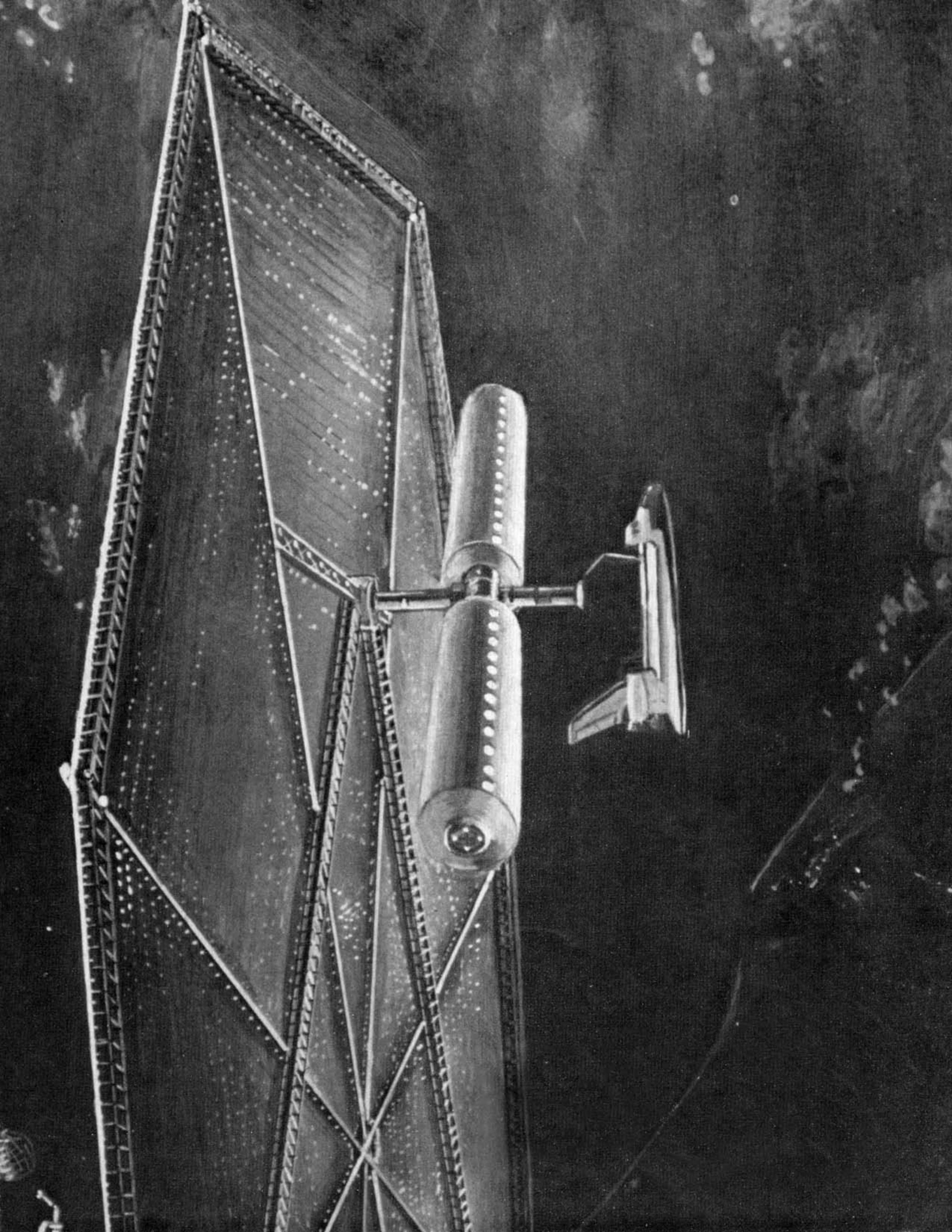
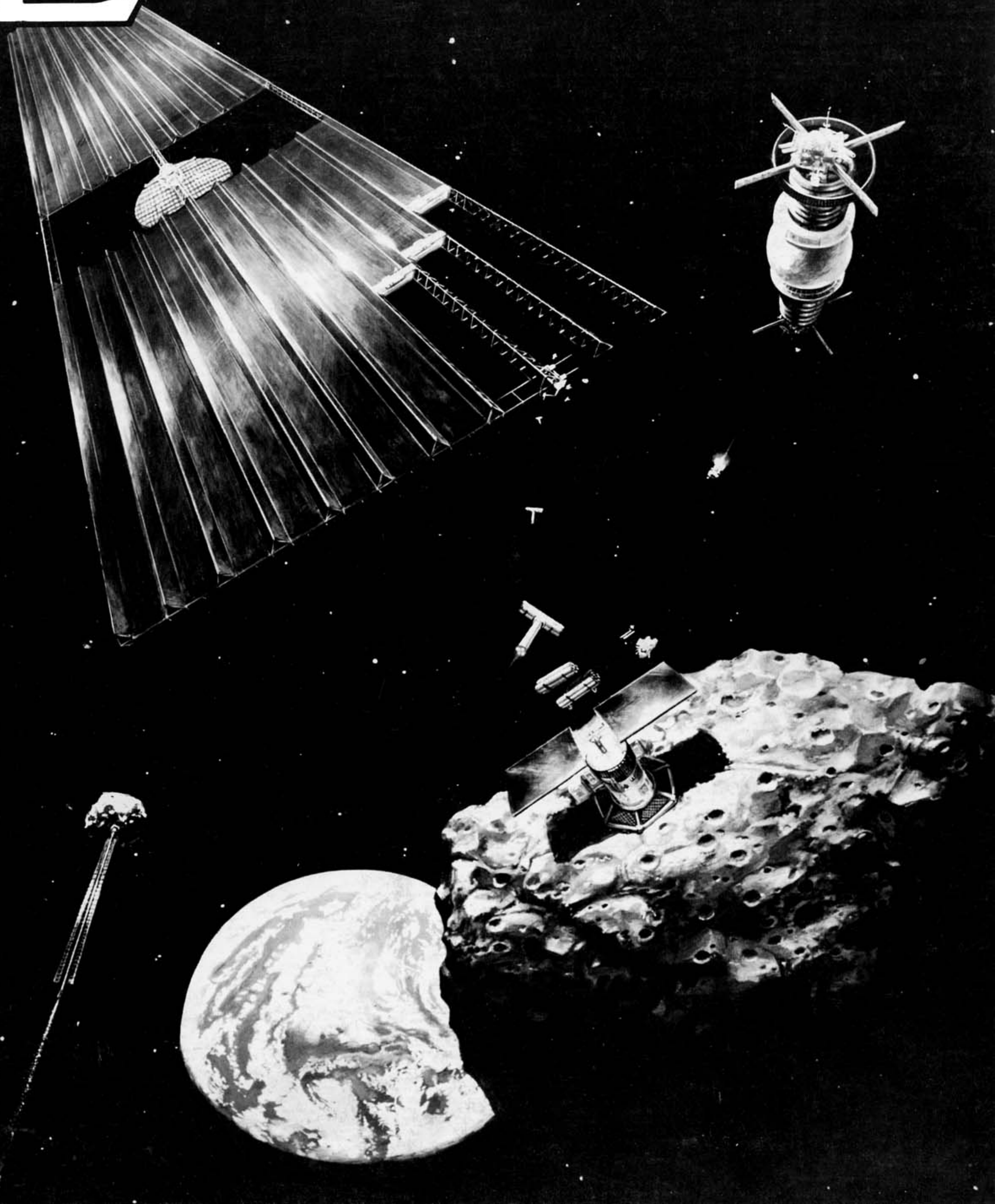


L5 NEWS

June 1978



L-5 NEWS

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In this issue:

1 **Boland's Committee Cuts NASA Appropriation** *Carolyn Henson reports on action in Congress.*

2 **Secret White House Studies Completed**

DOE, NASA's Plans for SPS *More reports by Henson*

3 **Space Industrialization Study Indicates Space Investments Yield High Returns**

4 **Shuttle Pollution**

Battelle Microwave Study

Skylab Update

5 **Intrinsically Valuable Materials in Space** *Stewart Nozette, a student at the Lunar and Planetary Lab of the University of Arizona, explores asteroid mining.*

7 **Some Rudiments of Economics for Non-Economists** *Boeing solar power study manager Gordon Woodcock gives us some background on how to evaluate SPS economics.*

10 **Responses to "Space Mines"** *Michael A.G. Michaud, Jack Salmon and Brian Maxwell respond to and enlarge upon issues brought up by K. Eric Drexler's "Space Mines, Space Law and the Third World".*

12 **Precis of "Domicile and Industry in Outer Space,** *and its epilogue,* **Some Reflections Beyond the City in Space** *International law expert J. Henry Glazer warns us ". . . contemporary treaty-making could hobble . . . the future of space settlement".*

15 **Inside the L-5 Society**

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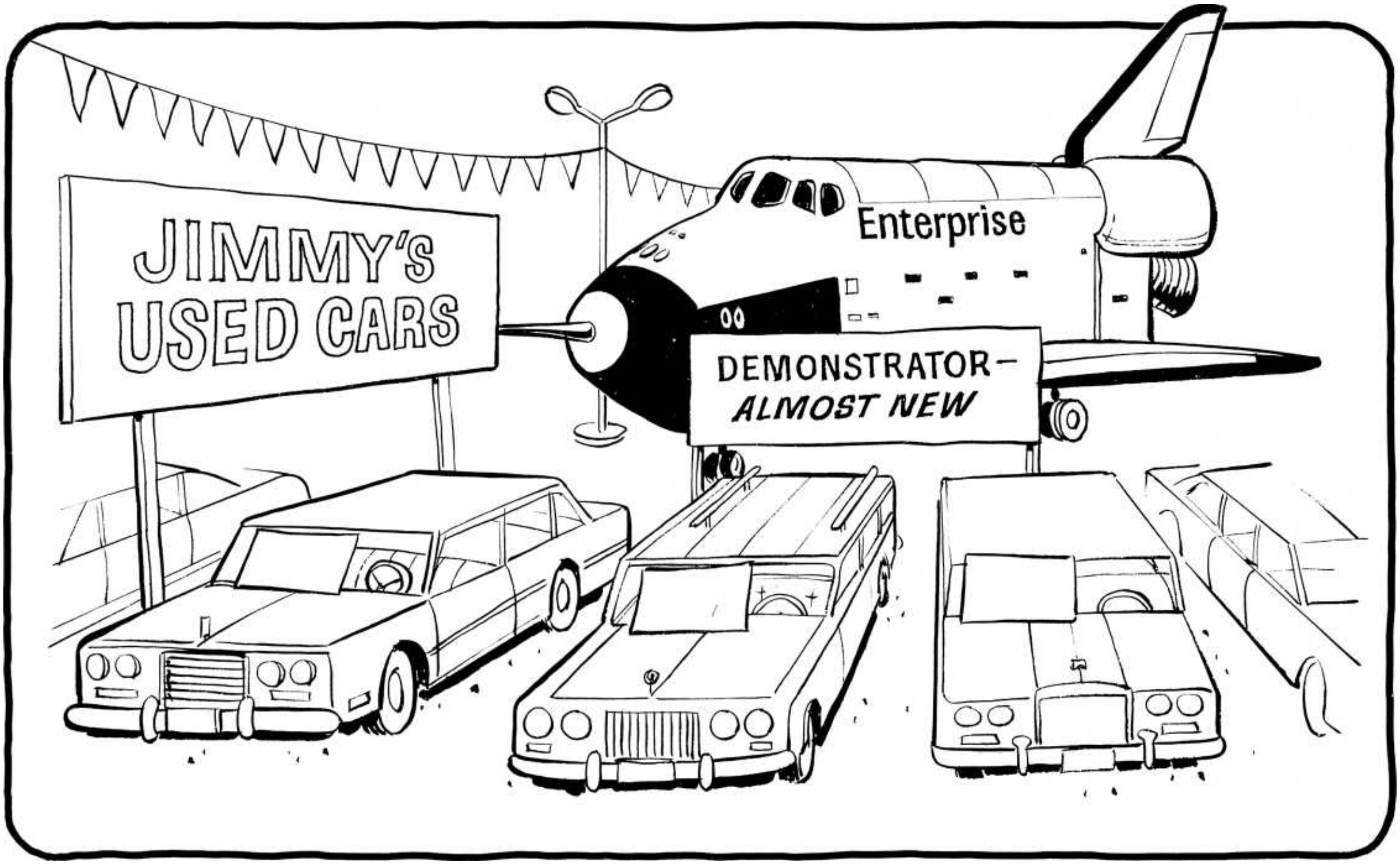
Cover: Lower left, a mass driver reaction engine is propelling an asteroid into Earth orbit. Lower right, a mining and processing operation has been set in operation on a second asteroid. Upper left, a solar power satellite is under construction, utilizing resources from the nearby asteroid. Upper right, a Bernal sphere space colony houses 10,000 people, many of whom are working as asteroid miners and SPS construction workers. *(Artwork courtesy Johnson Space Center.)*



Boland's Committee Cuts NASA Appropriation

by Carolyn Henson

The NASA FY '79 Appropriations Bill suffered several cuts before being passed by the House Appropriations Subcommittee on HUD-Independent Agencies (chaired by Rep. Howard Boland (D-MA)).

Perhaps the most serious cut was the deletion of funds for the Teleoperator Retrieval System (TRS), which must be funded *this year* in order to prevent Skylab from plunging to Earth. Besides the loss of a possibly still usable space station, Skylab could cause damage or injury when it crash-lands. The TRS will be available for other space projects after the re-boost of Skylab.

The Solar-Polar Mission was also cut. It would give us our first view of the polar regions of the Sun. It was planned as a joint US/German mission. If we drop our share of the project, the Germans may be unwilling to continue alone. A short delay in the funding could result in a long delay in the mission, because launch windows only occur at widely separated intervals.

Funds for the search for extraterrestrial intelligence (which, despite the interest aroused by "Close Encounters", received Proxmire's Golden Fleece award) were also deleted. Finding another civilization could have quite an impact on our society, perhaps comparable to the Copernican

The funds, reinstated by the House Science and Technology Committee and Senate Commerce Committee, to outfit the Enterprise for space (which would raise the shuttle fleet to five) were cut to $4 million—barely enough to keep the Enterprise from being cannibalized for parts in 1980 (as OMB has planned).

The $3 million reinstated for microwave testing and large space structures was also deleted. However, the $3 million for SPS research and the $7 million added to the Advanced Programs' $5 million allowed by OMB were left in the budget.

The NASA Appropriation next goes to the Senate Subcommittee on HUD-Independent Agencies. We are told that they will not vote on the NASA bill until sometime in June. If the Senate appropriation differs from the House appropriation, the conflicts will probably be ironed out in a House/Senate Conference Committee next July or August. It should be noted that, due to the Conference Committee process, that Boland's NASA cuts are by no means final. If Proxmire's Appropriations Subcommittee chooses to reinstate funds, the Conference Committee can work out a compromise between the House and Senate versions.

L-5's Legislative Information Service members are reminded of the surprise House floor vote called by Boland last summer when he was unable to get the Conference Committee to accept his demands to delete JOP. NASA Appropriations could be at least as exciting an issue this year. We'll keep you informed.

If you can't wait for information to come out in the L-5 News; if you need first class mailings to inform you of fast-breaking news in the U.S. Capitol, you can sign up with the L-5 Society Legislative. Information Service.

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Secret White House Studies Completed

by Carolyn Henson

Two secret White House studies were given to Carter in mid-May. The national security-oriented one, PRM23, has been signed by Carter and is now policy. Because it is totally classified, we must rely on "leaks" for knowledge of its content. The basic problem with PRM23 is that **it provides no goals** and only gives a superficial view of civilian space options. Some insiders view it as a blatant attempt by Defense Secretary Harold Brown, who headed the study, to take over NASA.

The civilian-oriented study is reported to be little better. While the solar power satellite option has been included (our sources say Frank Press was responsible for this), White House sources say that SPS doesn't fit within the NASA budget constraints proposed by the study. This study is also classified, so we must rely on rumor for details.

However, on the principle that "if you can't say something good about NASA, it's better to say nothing at all", White House advisors have urged Carter to avoid making a public statement on NASA. If he keeps quiet on the topic for now, he will later be able to change his NASA policy without loss of face.

The full impact of Carter's adoption of the PRM23 policy will not be felt until OMB releases the NASA FY '80 budget allowance next January. We hear it may call for the closing of Marshall Space Center and the disbanding of Advanced Programs. But a great deal could happen in the next eight months.

In the meantime, would it be possible to persuade Carter to reveal the contents of his NASA policy? He ran for office on an "open government" platform; perhaps it's not too late for him to return to his publicly stated ideals.

DOE, NASA'S Plans for SPS

by Carolyn Henson

DOE and NASA are opposing the $25 million Solar Power Satellite Research, Development and Demonstration Act (now numbered HR12505). Their line is that their "SPS Concept Development and Evaluation Plan" is adequate for SPS work.

What is the "Plan" and how does it differ from HR12505? The most immediately obvious difference is in funding. While HR12505 would kick off FY '79 with $25 million, the NASA/DOE plan has been running according to the table below:

However, the most serious differences between the "Plan" and HR12505 are in what the money will be used for. The "Plan" calls for definition of a final solar power satellite system this October. (DOE evaluators have already rejected several SPS design approaches, including O'Neill's "High Frontier" concept.) Then a comparison of SPS with terrestrial energy alternatives will begin in February 1979. A final decision to either reject or go ahead with an SPS construction program will be made in Nov. 1979. (i.e., early in FY '80).

TOTAL FUNDING IN
THOUSANDS OF DOLLARS
Fiscal Year

	1977	1978	1979	1980	TOTAL
Systems Definition	1,800	1,700	1,300	800	5,600
Space Related Technology	700				700
Environmental Factors	220	1,940	2,050	1,740	5,950
Socioeconomic Issues	164	537	537	322	1,560
Comparative Assessment	95	376	754	565	1,790
TOTAL	2,979	4,553	4,641	3,427	15,600

RESOURCES

The following table gives a brief summary of the resources allocated to NASA managed studies by the "plan".

	1977	1978	1979	1980	TOTAL
Systems Definition					
JSC	900	850	650	400	2,800
MSFC	900	850	650	400	2,800
Space Related Technology	700				700
TOTAL	2,500	1,700	1,300	800	6,300

As the NASA/DOE budget for SPS shows, space related technology research was terminated last year. Since then, the thrust of the NASA/DOE plan has been *evaluation* of what research has already been done.

Under the proposed Solar Power Satellite Research, Development and Demonstration Act, the heads of NASA and DOE would be directed to reinstate space related technology work and reopen consideration of SPS concepts to include photovoltaic, solar thermal and even orbiting nuclear power plant concepts.

SPS researchers assert that the DOE/NASA "plan" is a thinly disguised program to kill the SPS concept. They say they need time and money in order to have a fair chance to prove or disprove the viability of SPS. The NASA/DOE "Plan" tells them they've already had their chance—now it's time to evaluate. HR12505 will put the R&D show back on the road, leading—if no "show stoppers" are found—to a demonstration SPS in the mid-eighties which should finally prove or disprove the environmental and economic viability of SPS.

Will the show get back on the road? Watch Congress this summer for exciting developments.

SPACE INDUSTRIALIZATION STUDY INDICATES SPACE INVESTMENTS YIELD HIGH RETURNS

100,000 New Jobs by 1985?

A study just completed for NASA indicates that a world of pocket telephones and solar-powered homes and factories may only be a few years in the future. It also concluded that while sales of services originating from space are already producing world-wide gross revenues of more than $1 billion a year, by the year 2000 the figure will have grown to $10 or $20 billion with only minor advances in present technology.

These facts were reported in the summary of a space industrialization study recently completed for NASA's Marshall Space Flight Center in Huntsville, Ala., by two companies, Rockwell International and Science Applications, Inc.

The report stated that, with technological advancements in power production, structures, transportation and materials processing, earnings from space could well reach the $40 billion a year mark or beyond.

Space industrialization is already an international and multinational endeavor, with approximately 111 nations actively participating. At least five nations are now sponsoring materials space processing research with at least three organizations or nations actively conducting launches.

Of the four general categories of space industrialization, it is Information Services that is nearest to maturity. Commercially owned satellites that provide communications and information on earth resources and weather are already producing revenues. The remaining categories—products, energy and people in space—will require new technologies before markets can be opened up.

The Science Applications study predicted that, by 1985, 100,000 new jobs could be created in the United States alone as a direct result of a space industrialization program that includes development of technology for a satellite power system. Such a program would generate $800 million in tax revenues, but the total impact to the nation's economy would be much greater because of the many indirect jobs and services that would be made possible by these space industries.

By the year 2010, according to the study, new space industrialization jobs would increase to 1,900,000 and tax revenues to $20 billion. The contribution of the program to the gross national product (in 1976 dollars) would be from 200 to 800 billion dollars and the balance of trade impact could be as much as $50 billion.

One of the more interesting services that could be provided from space is the wireless pocket telephone, operating via satellite and offering almost instant communications with any part of the world. For instance, a paramedic in a remote African village would be able to get the best possible emergency medical advice by calling a medical specialist in New York, London or any other city of the world. A businessperson would have instant contact with associates and access to job and marketing information on a world-wide basis.

In the United States, satellite-linked portable telephones could be used by police, paramedics and other professional or semi-professionals, as well as the general public. The study predicted a long distance toll rate of about 20 cents.

The same space platform that provides telephone service may also provide direct broadcast educational television to homes, with five channels broadcasting programs 24 hours a day. A home adaptor for these broadcasts would cost less than $150, according to the report.

In addition to vastly improved communications, space industrialization can provide energy and products. A satellite power system could produce energy from sunlight that would provide power for processing materials and operating systems in space, or as an alternative to coal and gas on Earth. Properly commercialized and managed, this power source could also be exported to other countries.

Energy availability appears to be the key to space industrialization and the report recommends that its growth be divided into three 10-year intervals.

The space shuttle would be used to its fullest extent in the interval of the 1980s. The center of activities during this time would be in low Earth orbit with power provided by an orbiting power module like the 25kw power module now being considered by NASA for early development.

Activities during this interval would include establishing a geosynchronous (stationary) platform and a global weather and resources base to provide world-wide benefits. Later, a construction base, a space factory and a space operations center could be established as one facility in low Earth orbit. Here, the capability to construct large space structures would be perfected as a step toward construction of the satellite power system.

In the second 10-year interval (1990s) the capabilities of the space factory, the geosynchronous platform and the global weather and resource base could be in use and initial operation of a satellite power system could begin. Beyond the year 2000, oxygen and materials for massive energy-related projects at geosynchronous orbit would he obtained from the Moon.

Benefits in education, health and conservation of resources and productivity could be available to the entire world from information and observation services in the 1980s. The energy scarcity problem could be dealt with in the 1990s and, by the turn of the century, energy from space installations could become a worldwide energy source.

What will space industrialization cost in terms of taxpayer dollars? The Rockwell report states that the government cost of providing the opportunity to use the pocket telephone is about 33 cents per person per year. Annual per capita costs for other services the space industrialization program could make available include: direct broadcast education (five channels), 33 cents; world medical advice center, 20 cents; national information service (Library of Congress), 39 cents. None of the costs cited include user charges.

Throughout the entire program, services would continue to be expanded, new products would appear, and research would move toward full understanding, prediction and localized control of Earth's weather and climate.

The study predicts that in the future the public will become increasingly involved with space, first by directly receiving immediate and tangible benefits and later by directly participating in the space activity itself—even in space travel.

Shuttle Pollution

A shuttle propellant system could be developed which would yield only non-polluting water and carbon dioxide and cut the cost per launch by $1 million. The "miracle" booster? It's a liquid oxygen/kerosene burning engine similar to the Saturn 5 first stage.

However, several years ago Congressional budget cutters nixed the system, citing its $1.5 billion development cost. They settled on the cheaper to develop (but more expensive per launch) solid rocket boosters (SRB's) currently under development. The SRB's supplement the thrust of the three Orbiter engines, which emit water and hydrogen. The SRB's burn an ammonium perchlorate-based propellant which emits chlorine compounds in the ozone layer.

NASA's environmental impact statement calculates that 60 shuttle flights per year, using the SRB's, will decrease the atmospheric ozone concentration by 0.2%, which would correspond to a 0.4% increase in ultraviolet light reaching Earth's surface. The environmental impact statement indicates consequences to agriculture, ecology and the climate "are considered insignificant", and that there is "no conclusive evidence" that it would cause a detectable change in the rate of melanoma skin cancer.

In the lower atmosphere, while pollution is not expected to "exceed the allowable limits for human beings, wildlife or plants," the SRBs' exhaust will create hydrogen chloride, which can combine with rain to form dilute hydrochloric acid. This could temporarily damage vegetation.

However, the environmental impact statement pointed out that the shuttle will produce less pollution than the expendable launch vehicles currently in use: Scout, Delta and Titan III boosters. And if environmentalists complain loudly enough, the alternate non-polluting shuttle boosters may get funded yet.

Battelle Microwave Study

Long term biological effects of microwave exposure that may be associated with solar power satellite energy transmission are being studied by Dr. Richard Phillips, a research physiologist at Battelle's Pacific Northwest Laboratories. He is also considering electromagnetic and radio interference effects.

"The electromagnetic interference and biohazard studies will begin with surveys of known microwave effects," explains Phillips. "Battelle researchers will then identify unknowns or uncertainties in current knowledge and propose specific studies to fill in that knowledge." Battelle expects to complete the investigation by September, 1978.

In addition, the lab will sponsor a symposium on biological effects of extremely low-frequency electromagnetic fields in October, 1978. The symposium will concentrate on bioeffects associated with electrical power production and transmission.

Rockwell Receives Solar Cell Contract

DOE has awarded a one-year contract for $999,870 to Rockwell International, Thousand Oaks, California, to direct a program aimed at developing new techniques of growing gallium-arsenide thin films and using the films to make photovoltaic solar cells.

The overall goal of the program, which will be carried out by Rockwell's Science Center and four university subcontractors, will be to develop thin film solar cells that have a conversion efficiency greater than 10% and that can be produced at a cost of $100-$300 per peak kilowatt. Current laboratory thin film gallium arsenide cells have a conversion efficiency of approximately 6%.

The four schools and Rockwell will develop new crystal growth techniques, perform materials research, and develop processing techniques. The universities are: Brown University, Cornell University, Howard University, and North Carolina A&T State.

This project permits significant involvement of minority universities in DOE's photovoltaic research program. Besides directing the laboratory work at Howard and North Carolina A&T, Rockwell personnel, with the aid of faculty from Cornell and Brown, will also provide lectures and specialized instruction in solar cell technology at both schools. The program is expected to stimulate expanded photovoltaics research capabilities at the two universities and will help faculty and students gain additional expertise in photovoltaic technology.

The project is funded through DOE's Solar Technology program.

Skylab Update

If NASA decides to reboost the orbiting Skylab space station to a higher altitude—a possibility on the basis of recent findings by NASA crews who were able to recharge Skylab batteries and receive data from its computers—the move could provide an opportunity to reactivate and use the on-board systems and instruments in a variety of useful projects.

The large living quarters and crew accommodations aboard Skylab would be a welcome addition to Space Shuttle and Spacelab missions involving extensive mission equipment and long mission durations. In addition, useful experiments might be conducted with Skylab instruments, some of them in conjunction with complementary instruments planned for flight aboard Spacelab.

Another possibility concerns new experiments, missions and demonstrations made possible with the orbiter that might be feasible if Spacelab were docked with Skylab. Assembly and support of large space structures for communications, solar energy or other public service operations might be accomplished by this means, for instance.

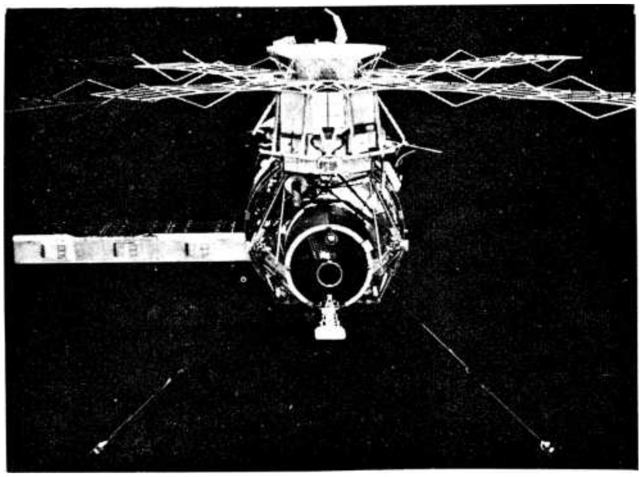
NASA's Marshall Space Flight Center has awarded parallel study contracts, each in the amount of $125,000, to Martin Marietta Corp, at Denver, Colo., and McDonnell Douglas Astronautics Co. at Huntington Beach, Calif. The two firms will conduct simultaneous but independent studies of the possibilities and benefits to be realized from reuse of Skylab.

The spacecraft is the largest payload in Earth orbit. It weighs 86 metric tons and is about 29 meters long. The main portion is cylindrical, 9 m in diameter. In orbit, Skylab is passing above the areas of Earth between 50 degrees north and 50 degrees south latitude.

Skylab was launched in May 1973 and manned during three missions by three different astronaut crews. The last crew left Skylab Feb. 8, 1974 at an altitude of 440 km. Skylab now is 408 km above Earth.

At the time the final crew departed, NASA estimated that the orbiting workshop would remain in space until 1983. Since then, the orbit has decreased and NASA has been adjusting its predictions. Contributing to the more rapid rate-of-descent is an increase in atmospheric drag which in turn is caused by sunspot activity.

When it became evident, last February, that Skylab could begin reentry into the Earth's atmosphere as early as late summer of 1979 and as late as the second quarter of 1980, NASA project managers began attempts to reactivate the spacecraft. Engineers from the Marshall center, controllers from the Johnson center and tracking crews from the Goddard center spent a week at a ground station in Bermuda, checking out systems that have been dormant aboard the spacecraft for the past four years. The purpose of their activities was to check out the capability of Skylab to respond to commands as a prelude to activating the thruster attitude control system. The results were most encouraging, and plans are presently underway to reactivate Skylab once again this month when the system may be used to reduce atmospheric drag and prolong the Skylab's orbital lifetime, perhaps for several months.



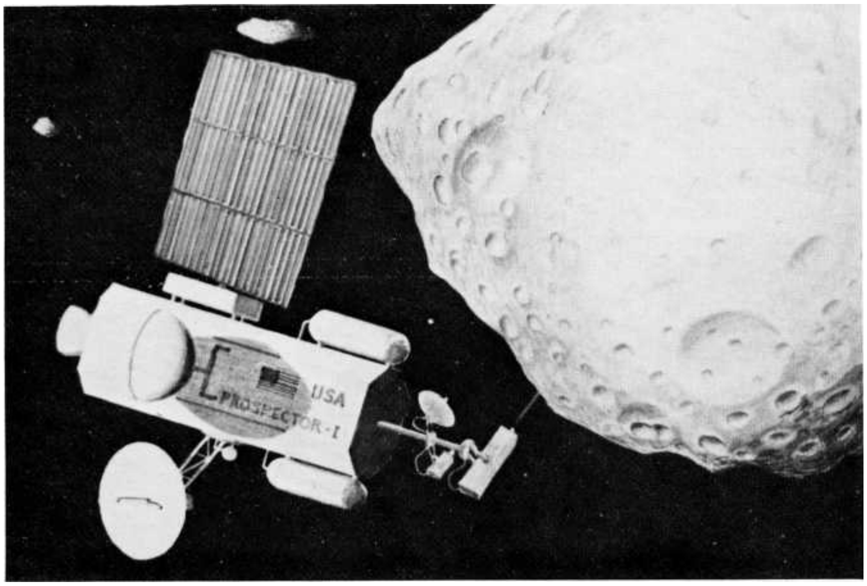
Skylab looked like this four years ago in its final fly-around, made by astronauts Jerry Carr, Ed Gibson and Bill Pogue just before they returned home. At the time (February 1974) Skylab's orbital lifetime was calculated at 10 years. Atmospheric drag caused orbital decay from its original 237 nautical miles down to 220 in 1978. Photo was taken from the Skylab-4 command and service modules.

Intrinsically Valuable Materials in Space

by Stewart Nozette

At present, cost seems to be the overriding factor in any plan to expand our space program. Does an expanded space program mean that only money will be spent, and that there will be no substantial economic payoff? Supporters of space industrialization and space colonization have argued that there can be substantial economic payback from these types of ventures.

Satellite solar power stations have been suggested as one way to derive economic payback from space industrialization. In this article I will explore the possibility of other faster methods to pay back the initial investment required to set up space manufacturing facilities. Supporters of such large scale- projects would see their efforts gain large amounts of support if, within a few years of initiation, a large quantity of intrinsically valuable substances could be delivered from space factories. Space utilization could proceed in steps with each step providing the economic return to pay for itself. Energy is one attractive justification, but power satellites would require a large initial investment before full payback could be realized. During that time new energy technology developed for terrestrial use could reduce the payback from space systems, and make their expense difficult to justify. Examples might be fusion technology or a practical method of harnessing tidal and thermal ocean effects.



A prospecting probe approaching an asteroid. (Artwork courtesy Robert Lovell.)

This is not to say that satellite solar power stations could not be an important source of energy in the future. However, we must seek other methods of economic payback so as not to suffer from unforeseen developments in one specific area. There are subsidiary space manufacturing and processing schemes that could support the cost of these activities. Specifically what are prospects for finding intrinsically valuable materials in space?

The oil embargo of 1973 dramatically showed our country's dependence on imported oil for energy. Yet oil is not the only thing that we must import to maintain our highly industrialized society. Many of our key minerals also must be imported from other countries. The energy crisis has dramatically illustrated the fragile relationship between resources and the industrial society they helped create. Materials such as helium, chromium, platinum, nickel, cobalt, copper and petroleum are discovered, turned into resources, used in many productive ways, become indispensable, and then become scarce. Even at present use rates known reserves of several important minerals will be exhausted in 200 years.' Such estimates are difficult to make due to the change in supply and demand. The point is that we will run out of these things sooner or later.

Also, some parts of Earth are relatively high in mineral reserves, and other parts low. North America, for example, is rich in molybdenum, poor in manganese, tin and chromium. Asia is poor in molybdenum, but rich in manganese, tin, and tungsten. Most of the world's chromium comes from South Africa and Rhodesia. Cuba and new Caledonia supply about half the world's nickel.

How long a reserve of a mineral lasts depends not only on its supply but how fast it is used, and this rate of consumption is increasing. The metal consumed worldwide since the start of World War II exceeds the total metal production of all previous years. The United States has long been the largest consumer. It now imports most of its aluminum ore, chromium, manganese, nickel, and platinum.' Except for bulk non-metallic materials such as gravel and cement, the U.S. is self-sufficient in only iron, magnesium, molybdenum and a few minor metals. This puts our country in a fragile position. Our wealth is primarily derived from ready access to materials and mineral resources. What would happen if instead of an oil embargo, we faced a nickel/chromium embargo? The results could be disastrous.

Can we look to space to help gain independence from foreign mineral sources? In considering likely places for mineral deposits, both major and minor planets may be considered. Major planets are gravitationally disadvantaged and too far away. The moon is lacking in many of the minerals with high intrinsic value. Most reduced metal found in lunar soil is probably derived from meteorites impacting the surface. The moon lacks many of the processes that concentrate ores on Earth such as hydrothermal solutions and active tectonic processes.

To be a likely candidate the source in question must be close in terms of the velocity interval required to reach it. It must be high in intrinsically valuable metals which can be obtained with a minimum of processing. The earth crossing asteroids may provide this source.

The basic reflective spectra of an asteroid can give us some idea of its surface composition. We can compare the spectrum obtained from an asteroid with the spectra of meteorite samples we have here on Earth. In this way a basic idea of asteroidal composition may be obtained. Other workers[3] have obtained these types of data from several earth crossing asteroids. One likely candidate is 433 Eros. It has a spectrum in reflected light resembling a group of meteorites known as H group chondrites. A typical whole-rock[5] analysis is shown below

Compound	**Wt. %**
Iron—Fe Metal	16.30
Iron FeO	10.24
Nickel—Ni	1.74
Silicon—SiO2	36.74
Magnesium—MgO	23.44
Calcium—CaO	1.60
Aluminum—Al2O3	2.04
Platinum—Pt	5-9x10(6) gm/gm metal
Sulphur + Iron	5.48
Chromium—Cr203	.55

In meteorites, iron, nickel and trace metals tend to occur together in metallic inclusions similar to the one shown here. The oxides occur in the silicate minerals, and sulphur occurs with iron. Thus the important metals are already reduced and can be extracted, possibly by a magnetic method.

What would 433 Eros be worth on today's market? We can assume that to get the body back to near-Earth space, the silicate portion may be used as reaction mass for a solar powered mass driver. Eros is a good target because the velocity interval for return of its material is on the order of 9-13 km/sec.

A rough back of the envelope sort of calculation is adequate for this level. Observations of Eros indicate a size of about 35x26x7 km. This is a bit too large for exploitation, but it serves as a good example, because its reflective spectra and orbit are well known. Using this size we get a volume of about 3.92x10(18)cc. Approximate whole rock densities for H-group chondrites are about 3.8 grams/cc. So a total mass would be on the order of 1.5x10(16)kg. Assuming a whole rock analysis similar to the one given previously, Eros would contain about 2.6x10(14)kg of nickel and 2.43x10(15)kg of iron. These elements would he in metallic form. Concentrated in these metallic phases would be about 2x10(10)kg of platinum. Dispersed through the entire body would be about 5.6x10(13)kg of chromium in the form of Cr203. We can see that a direct value calculation would have little meaning, because at present prices for some of these materials the value would exceed the gross national product of the United States.

In conclusion, asteroid utilization appears to hold a promise of payback on the same scale as satellite solar power. A typical near-Earth asteroid might contain large amounts of vital metals now imported from other countries. The materials gained could supply a large program of space industrialization. Some of the more precious metals could be exported for profit. The cost of such an asteroid mining scheme is not well known at present. But the potential gains surely warrant some funding for closer investigation. We are running out of time. This situation grows more critical as time goes on. By the end of the century we will look with great interest at the vast wealth present above the atmosphere.

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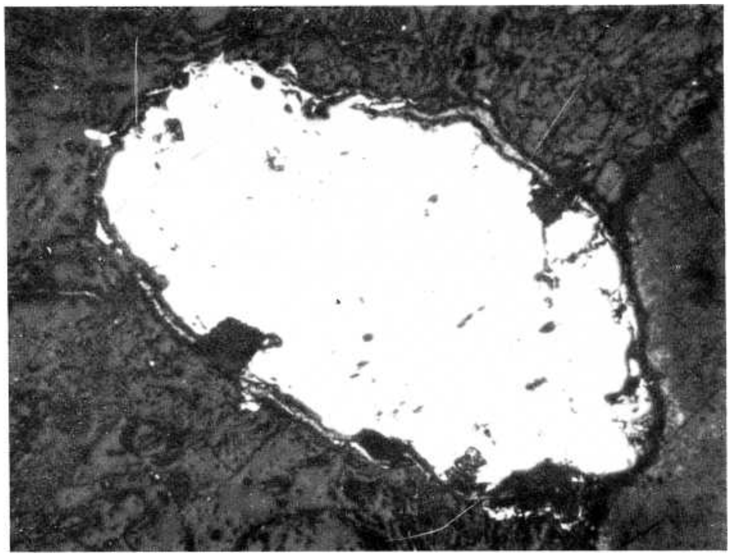


Iron/nickel, iron sulphide in a H4 chondrite. (Photo courtesy Lunar and Planetary Laboratory, University of Arizona.) Scale: 1.25 inches = 0.5 mm.

Some Rudiments of Economics for Non-Economists

by Gordon Woodcock

Historical background

Questions about energy supplies and use have their roots in economics issues. The history of the industrial revolution provides a background to the relationships between economics and energy. Until quite recently in human history, of course, energy was not an important problem. Early and historical people needed little of it and what little they needed was supplied by muscle power and firewood. The early developed civilizations such as the Greeks and Romans did not perceive a need for anything like industrialization because their economic system was built on the widespread use of slavery. The scientific principles involved in building machines to do work were known to the Greeks. Their ideas regarding proper occupations for educated men, however, discouraged the idea of putting scientific knowledge to "base" (i.e. practical) use.

The first energy crisis actually occurred before the industrial revolution. In England in the 16th century, demands for wood included heating, building of shelters, and shipbuilding. Wood was actually imported from the continent and the colonies, and a price inflation much like the current one in oil occurred. The result was a turn to coal for heating and ironworking. (See the March 1977 **L-5 News** for a more complete discussion by Romualdas Sviedrys.)

Also in England, but later, in the 18th century, initial steps toward industrialization were taken. At the beginning of that century, primitive steam engines were developed. These machines were originally used to pump water out of coal mines. By the middle 1700's, sources of capital were becoming available from trading the raw materials and products of the English colonies. Machines had been invented that vastly improved the productivity of manual work in spinning and weaving. The Enclosure Acts had displaced many poor farmers and rural dwellers to the cities where they sought employment.

Industrialization was inevitable! The earliest factories were built even before the advent of mechanical power. Its use began with water power, but with the invention of the improved steam engine, steam began to see widespread use.

Thus began a process that still continues. It has profoundly changed the predominant economics of the world. The pre-industrial situation was one of scarcity in which nearly everyone eked out a bare subsistence; a life that has been described aptly as "solitary, poor, nasty, brutish, and short." Only a few were powerful and therefore rich, and their pleasant existence was at the expense of the poor. Now, in the industrialized countries, most of the population enjoys a material existence that would have been the envy of the rich a few centuries ago. One often reads of philosophical views to the effect that the high material standard of living of industrial societies has somehow "degraded" us. It is my view that those who express such opinions have not tried the primitive way of life they espouse, and have little appreciation for the hardships of life as experienced by the average citizen of, say, the middle ages. The contemporary view of "roughing it" - - mine, at least - - is a few days spent camping in the wilderness with elegant high-technology equipment made of aluminum, stainless steel, and various synthetics!

Today our primary source of energy is oil, but the reason for oil's displacement of coal was primarily economic rather than due to a shortage. Oil is cheaper to get out of the ground and more convenient and cleaner to use. Oil, however, is becoming a critical resource and some changes must occur. The industrialized societies have prospered and grown at the expense of profligate consumption of resources: Even at today's use rates, however, the availability of most resources is not critical if one is willing to think of using lower-grade sources, such as production of aluminum from clays rather than bauxite. As raw materials become more precious, recycling becomes economically more attractive.

One resource that cannot be recycled and is not so plentiful is the set of hydrocarbons that we call fossil fuels. It will be necessary in the next few decades to find some alternative to our present dependence of this set of resources. This necessity for alternatives is our "energy crisis". To evaluate the potential alternatives we must take an excursion into the mysterious realm of economics. It is made the more mysterious by frequent discussions of such esoteric matters as monetary theory and the like. To understand something about energy needs, however, only the rudiments of economics are necessary. And one might even argue that these rudiments are based on common sense.

Basic concepts of economics

Economics is the science of wealth. Lest we turn someone off with the use of that word, we do not use it in the sense of riches, but rather in the generic sense of the goods, services, and knowledge produced by human societies. We do not mean money. Let us consider for a moment what money is. It is often called a medium of exchange. Although historically moneys have often had intrinsic value as exemplified by gold, modern moneys have little actual value except as societies agree on the universal exchangeability of money for things of real value. This is becoming increasingly true as our monetary systems evolve in abstraction from coinage to paper bits of data. Money is essential to the functioning of a complex and diverse economic system. Without it, we would be reduced to barter.

Now that we have discussed money briefly, let us see if we can structure a concept of economics without discussing money further. To begin with, how is wealth created? Clearly, by the products of effort. And how is it destroyed? By the ravages of time, the "corruption of moth and rust," by consumption as in the case of food, or by becoming irrelevent as in the case of superseded knowledge. One could think of a "half-life" for wealth — if now more were created, how long would it be before half of what we had was gone? Some human creations last a long time, as the great cathedrals and castles of Europe, not to mention the pyramids (are the pyramids irrelevant?). But most are gone quickly. Perhaps the half-life would be ten years, perhaps fifty. But our total wealth is clearly a balance of creative and destructive forces.

The ability to create wealth is productivity. As productivity is increased, the balance of creative and destructive forces shifts in the direction of the creative effort in human work, most commonly measured in manhours. The amount of wealth produced by a manhour is determined by productivity. A person aided by a machine can ordinarily produce more than an unaided person. This is the advantage of industrialization. (As has often been observed, however, the machine operator may receive less job satisfaction.)

The increased productivity of industrialization is not all pure gain. In the case of an artisan or laborer working with simple tools, the total effort involved to produce a personhour of production labor is only slightly more than one personhour: some labor is invested in the tools and some goes to supplying raw materials and perhaps to packaging and marketing the product. Several personhours, however, are generally required to effect a personhour of production labor in a large machine-equipped factory. Much labor is invested in the factory and tools and equipment. Support labor includes factory and equipment maintenance, raw and in-process materials logistics, production planning, and so forth. There probably is, as argued by [I], an optimal level of capitalization (investment in industrial production) for any product or process. The optimal level will change as the availability and costs of technology and labor change, but it is not valid to think that more capitalization is necessarily better. (Schumacher seems to believe that productivity in the highly industrialized economies could be increased by reducing the present levels of technology and capitalization. I do not agree, and suspect that this view may have been ideologically motivated. I will discuss my reasons in the next article.)

Several basic economic concepts are pertinent to energy issues and to the possibility of large-scale human settlements in space.

The market is the economic construct for the exchange of goods and services among individuals and organizations. A great deal of economic theory is based on the idea of the free market. In an idealized free market, sellers offer goods and services in open price and quality competition and buyers have complete freedom to buy from the seller of their choice. The antithesis of the free market is the totally planned economy: no competition, no choices. The virtues of the free market are demonstrated self-regulating characteristics and in the improvements in products, services, and prices that occur through competition. Self-regulation here refers to the adaption of types and quantities of goods and services to buyer wants. An electronic analogy for the free market is distributed processing with negative feedback; the planned economy is like centralized processing with far less feedback. The idealized free market also affords great opportunity for mischief and in some situations is not workable; practical economies have varying degrees of legal regulation, planning and control.

The *law of supply and demand* simply states that in a free market the prevailing price for a given item will vary until the supply equals the demand. A rising price tends to increase supply — more producers and sellers trying to get in on a good thing — and tends to shrink demand — fewer buyers willing to pay the higher price. Even in a partially controlled market, this law may function. During the oil embargo of 1973-74, the dollar price of gasoline was regulated. But the manhours (real) price escalated dramatically when one included the hours spent waiting in lines at service stations.

The change of demand with price is sometimes quantified. The *elasticity* of demand measures how much the demand changes for a given change in price.

The *division of labor is* the economist's name for the idea of specialization. A worker who only lays bricks is likely to be a more efficient bricklayer than one who also does plumbing, TV repair, carpentry, computer programming, and any other odd job that comes along. (As do-it-yourselfer I ignore this premise in my personal life.) Many skills in a technological society are so highly sophisticated that one simply must specialize and devote most of one's working time to the specialty in order to be proficient. Our economy requires many hundreds, if not thousands, of specialty skills. The division of labor has a hearing on the establishment of self-sufficient settlements in space since they will require some number of technological as well as other skills. The population must be large enough to encompass all the required skills. I don't know how large this is and have never seen a report of an analysis of minimum population size for a space settlement performed with division of labor in mind. Such an analysis might, among other things, help to dispel the notion that space residents will all be astronauts and computer scientists.

In order to have a highly industrialized economy, one must pay for the construction of factories and equipment. This is the problem of *capital formation:* where does all this wealth come from? It must, of course, come from the products of human labor. It is wealth diverted from immediate consumption. Think of it this way: if you had $5000, you could buy a new car (consumption) or purchase some capital stock in a corporation (capital formation). Those who invest some of the fruits of their labors expect a return, that is, they expect some reward for having chose investment rather than consumption. This may take the form of an increase in the value of their investment, e.g. in the price of the stock, or in the form of periodic payments, e.g. dividends, or both. I have seen capital gains and dividends called "unearned income" by ultra-liberals. This seems to be a case of ideology displacing common sense. One who elects to invest rather than consume deserves a fair return.

There are, of course, other means to capital formation. In the early clays of industrialization, the workers were grossly underpaid: their wages were small compared to the actual wealth they produced. Some factories made what today would be called "obscene profits." Ploughed back into the business, these profits represented intense capital formation and produced rapid growth. (This early exploitation of workers led to the philosophies of "public" rather than private ownership of the means of production. When put into practice, these philosophies have resulted in ownership of the means of production by the government.) Regardless of ownership, capital formation is absolutely necessary to an industrialized economy. If the means of production are government-owned, "investment" tends to be compulsory rather than voluntary; pay scales are set such that capital formation comes directly or indirectly from operating profits. (Never mind what they may be called, they are **profits.)**

I am spending quite a few words on investment because it is important to our subject in two ways: first in evaluating growth versus no-growth policies, and second, in the questions of economic feasibility of solar power satellites and of space settlements.

An economic unit, be it a corporation, a family, or a government, may also acquire wealth by *borrowing.* Borrowing is the act of acquiring real wealth now in return for a promise to repay with a greater quantity of wealth later. And where does the real wealth now come from? From the same place that capital formation comes from: investment. And what are these sources of investment? Some comes directly from individuals, but most comes from institutions: banks, savings and loan associations, insurance companies, retirement funds, investment institutions (e.g. mutual funds) and the like. All these sources have something in common: they are investing *your money:* your savings, your insurance premiums, your retirement fund, your mutual fund shares. The future income you are counting on from these kinds of sources is undoubtedly substantially tied up in someone's *promise to pay*. (The rest is probably tied up in the continued economic success of some group of institutions and companies.) Remember, all real wealth comes from the working population, not from a printing press. The ability of these institutions to make good on your investments is predicated on financial factors that assume continued economic growth.

The issue of economic growth versus limits-to-growth or no-growth thus has profound implications for everyone's future, both economic and political. Can you imagine voluntary investment in a no-growth or permanently declining economy, wherein the investor could count on his investment declining in real value? Or a lender voluntarily lending at negative interest rates? Yet the economic functions of investment and lending would still be required, although perhaps to a lesser degree. If not voluntary, then what? The answer is obvious.

Economic growth could be defined as an increase in aggregate perceived wealth. I have used the term **perceived** wealth to avoid the erroneous implication that economic growth equates to ever more profligate consumption of dwindling resources. Is endless economic growth possible on a finite planet? I don't know. I am not convinced the answer is negative, but I suspect the question is at any rate irrelevant.

One additional factor is extremely important to increasing productivity and to economic growth. This is the accumulation of knowledge and its associated technology. It is easy to understand that improvement of productivity depends in some way on development of knowledge and technology, i.e. better machines lead to greater productivity. It is extremely difficult to quantify this in any way. Improvements in productivity come from capital formation, from technology, and perhaps from other sources. The effects of the sources cannot be separated to allow measurement of each. I have seen some learned judgements that allocate productivity increases roughly equally between capitalization and technology. But no one knows if this is right. A common problem in analytical economics and the construction of economics models is that one cannot separate variables and effects and measure them in the laboratory. This is especially true of dynamics models (see below). It is as if we were trying to understand atomic and nuclear physics solely from observation of stars and other cosmic phenomena. It is not surprising that various economic models differ in their predictions.

Some simple examples of economic modeling

Two techniques are of particular interest to this subject - one because it has application in the analysis of space settlements and the second because it serves to illuminate some of the doomsday predictions of the World Dynamics studies.

The first example is input-output modeling. Input-output models are schemes for modeling the interrelationships in a complex economy. They amount to linear systems of equations. Let's use a simple example for a hypothetical space settlement. The actual values used in this example are assumptional, not supported by an analysis, and therefore no conclusions should be drawn from the results.

In a space settlement, suppose that:

Seventy-two working hours are available per person-week, not counting purely personal time.

Four hours per person-week are lost due to illness and other lost time factors.

Five hours per person-week are required for habitat maintenance.

Ten hours per person-week are required for agriculture.

Twenty hours per person-week are requited for domestics, trade, and so forth.

Settlement administration requires two hours per person-week plus 1/2 hour of export labor and 1/2 hour per hour of logistics operations labor.

Raw material throughput is 0.01 tons per manhour of export labor.

Finished product is 0.25 tons per ton of raw material.

Logistics operations require five hours of labor per ton of raw material

The problem is to determine the productivity of the settlement. The above assumptions can be arranged into a set of equations represented by the following matrix:

$$\begin{array}{cccccccccc}
\text{lost time} & \text{maintenanc} & \text{domestics, e} & \text{agriculture} & \text{administration} & \text{logistics} & \text{export labor} & \text{raw materials} & \text{finished product} & \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 4 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 5 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 20 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 10 \\
0 & 0 & 0 & 0 & 1 & -.5 & -.5 & 0 & 0 & 2 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & -5 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 72 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & -100 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -4 & 1 & 0
\end{array}$$

This matrix can readily be solved with the following results:

.049225 tons of finished product are produced per person-week

.1969 tons of raw material are processed per person-week

19.68 hours of export labor are available per person-week

.9845 hours of logistics labor are required per person-week

12.33 hours per person-week are required for administration.

To construct one 100,000 ton SPS per year, a settlement size of 39,000 people is calculated. The result is sensitive to productivity assumptions. If the productivity is increased by a factor of tell, i.e. to 0.1 tons of raw material per hour of export labor, the settlement size is reduced to about 5600 people. This example input-output model illustrates a type of analysis badly needed in the continuing study of space settlements. The studies of which I am aware have used the frivolous assumption that all (or at least most) of the settlement people are available for export labor. And no careful estimates of productivity have been made, to my knowledge. In fairness to the studies I am referring to, they simply did not have the time or resources to get into these matters. I think they should, however, be given high priority for future work.

The World Dynamics models developed by Meadows and others are a form of dynamic economics models. Whether these models are more than illustrative of a potential problem is debatable. They predict the collapse of civilization in the not so distant future due to exhaustion of resources, or massive pollution, or failure of food production, et cetera. The models are aggregates of differential equations numerically integrated by a computer. As discussed above regarding the problems of economic modeling, the key question is whether the equations have any relationship to the real world.

One can construct a very simple dynamics model that illustrates the crisis behavior exhibited by the World Dynamics models. One needs only to simulate exponential growth and a finiteness limiter to growth. Take the case of finite energy resources: Assume that (I) the pricing of the finite resource is inversely proportional to the amount remaining raised to some exponent,

$$\text{Price} = \text{Initial Price} \left(\frac{Q}{q}\right)^{a}$$

Assume that the law of supply and demand operates so that the amount consumed is depressed by a factor inversely proportional to the price raised to some exponent:

$$\dot{q} = (\dot{q} \text{ at Initial Price}) \left(\frac{\text{Initial Price}}{\text{Price}}\right)^{b}$$

Assume that the initial consumption is one percent of the quantity remaining, and that without the price depression of consumption, the consumption would grow exponentially;

$$\dot{q} = .01Q\,e^{ct}$$

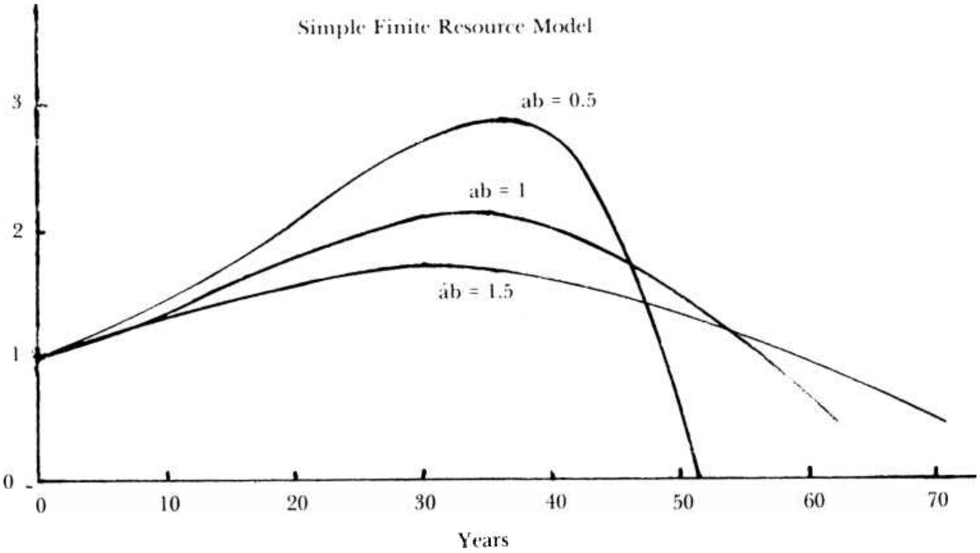
These can be combined into a differential equation;

$$q = .01Q^{(1-ab)}\,q^{ab}e^{ct}$$

The equation has an exact solution:

$$q = Q \left\{ 1 + \frac{.01}{c} (1\text{-}ab)\,(1\text{-}e^{ct}) \right\}^{\frac{1}{1\text{-}ab}}$$

This model is so simple that you don't even need a computer! The rate of consumption is plotted for three values of the exponent ab below.



It is interesting to note that the consumption closely follows an exponential behavior until relatively close to the end. Real changes in price tend to be irregular and to take place in jumps. This kind of model would predict that in between price jumps, the consumption would tend to follow exponential behavior, but on a new (and lower) curve after each price jump. Interestingly, that seems to be what Is happening in this country with energy consumption.

In the next article we will take alternative views of energy supplies and futures.

1. Schumacher, E.F., **Small is Beautiful**, Harper & Row, 1973
2. If the rate of inflation is greater over the term of a loan than the rate of interest established for the loan, the borrower is in the fortunate position of being required to repay less real wealth than that which he or she acquired through the loan.

Responses to "Space Mines"

Eric Drexler's article on the legal status of space mining was interesting, but perhaps a little too optimistic. While one might interpret the Outer Space Treaty as flexibly as he suggests, that may not be the only treaty that will affect the mining of extraterrestrial resources. There is now before the U.N. Outer Space Committee a complete draft of an "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies." This draft was put together by the Austrian Delegation, and has the tentative agreement of the other delegations to the Outer Space Committee.

This agreement draws heavily on the. language of the Outer Space Treaty, including clauses referred to by Mr. Drexler. But it appears to go farther in some respects, and it has articles which bear directly on the utilization of lunar and asteroidal resources.

The treaty's preamble notes the (unstated) benefits which may be derived from the exploitation of the natural resources of the Moon. Article I states that references to the Moon in the treaty include orbits around or other trajectories to or around it, and that the provisions of the treaty will also apply to all other celestial bodies within the solar system, other than the Earth, until such time as specific legal norms may enter into force with respect to those bodies.

Article IV provides that the exploration and use of the Moon will be the province of all mankind and will be for the benefit of all countries, irrespective of their degree of economic or scientific development. States are to inform the U.N. and the public of their activities concerning the exploration and use of the Moon, and the results of their missions.

Article VI requires states to take measures to prevent the disruption of the lunar environment or the contamination of it, and to inform the U.N. in advance of radioactive materials placed on the Moon. This article also provides for the creation of protected international scientific preserves of the Moon.

Article VII allows states to engage in the exploration and use of the Moon anywhere on or below its surface, as long as they do not interfere with the activities of other states. Article VIII allows states to establish manned and unmanned stations on the Moon, provided that they use only the area required for the needs of the station.

The most important part of the treaty for prospective moon-miners is Article X, under which the Moon and its natural resources would be considered the common heritage of mankind. The Moon would not be subject to national appropriation by any claim of sovereignty, or by use or occupation. Neither the surface nor subsurface of the Moon, nor any part thereof or natural resources in place, could become the property of any state, international organization, national organization, non-governmental entity, or any natural person. States signing the treaty would undertake to establish an international regime to govern the exploitation of the natural resources of the Moon as such exploitation becomes feasible. The main purposes of this regime would include (1) the orderly and safe development of the Moon's natural resources; (2) the rational management of these resources; (3) the expansion of opportunities in the use of these resources: (4) an equitable sharing by all states in the benefits derived from these resources, whereby the interests and needs of the developing countries would be given special consideration.

Under Article XIII, states will bear international responsibility for national activities on the Moon, whether such activities are carried on by governmental agencies or by non-governmental entities, and are to ensure that non-governmental entities under their jurisdiction engage in activities on the Moon only under the authority and continuing supervision of the appropriate state. Article XIV makes most of the articles of the treaty apply to any international inter-governmental organization which conducts space activities (e.g. the European Space Agency).

Article XV provides that all space vehicles, equipment, facilities, stations, and installations on the Moon will be open to other states.

The draft treaty contains a number of other provisions concerning the banning of nuclear weapons and other weapons of mass destruction from the Moon or orbits and trajectories to or around it; the banning of military bases, military maneuvers, and the testing of weapons; the prohibition of the threat or use of force on the Moon or from the Moon; scientific cooperation, and shelter for personnel in danger; consultations and disputes; and other matters.

The key to Moon mining will be the international regime mentioned in Article X. But even the present draft treaty implies that private enterprise will not have free run of the Moon—or the asteroids. The draft treaty, and the yet-to-be-agreed international regime, also would apply to asteroids. It would appear that, in addition to mining, planetary terraforming might be restricted.

The full Outer Space Committee will meet in New York June 26 through July 7. Well before that time, the U.S. Government will have to take a position on the draft treaty.

Michael A.G. Michaud
Bethesda, MD

U.S. Delegation to the Outer Space Committee

Who will represent the United States at the Outer Space Committee June 26-July 7 where the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" will be negotiated?

The tentative list (as of May 15) shows Gerald B. HeIman, Deputy Assistant Secretary of State for International Organizational Affairs as delegation head; the first alternate will be Neil Hosenbal, general counsel for NASA; second alternate, Steven Bond of the Stale Department: senior advisor, Herbert Reis, head of the U.S. mission to the United Nations; advisory board members Irwin M. Pikus (State Dept.), Kalman Scheafer (Federal Communications Commission), Commander Edward Melanson (Dept. of Defense), Helen Cupperman (NASA) and Edward Iift (NASA).

Eric Drexler's article on "Space Mines, Space Law and the Third World" makes some good points about the need to expand the world's understanding of the potential of space, but I think there are some basic problems with his image of what international law is and how it works.

Its very important to remember that international law is not like the domestic law of the US or any other country. In the US a sovereign—i.e., legally supreme—power makes laws which are binding upon itself and its citizens, and which it has the right and authority to enforce with its police and courts. But there is no one sovereign power in international law. International law is made by the mutual agreement of a number of sovereigns, each of whom is bound only to the extent that it feels and acts bound. There is no central court system with the right and the power to settle issues of law whether the parties concerned like it or not. Nations take international law fairly seriously for a lot of reasons, including the important one that is usually easier and cheaper to act legally than illegally. It saves an awful lot of hassle with everybody, including one's own citizens and officials, if a law exists on the matter at hand. Of course there are disagreements between sovereign nations on just what the law means, and other sovereigns are at liberty to try to enforce their particular view by means of diplomatic nasty notes, economic pressures, even war if it's important enough. But this means that international law is a sub-division of international politics, not a replacement for it: what laws are established, who they bind, and whether a nation stays bound even when doing so will cost it becomes a matter of the politics of law rather than of the wording.

From this perspective, Drexler's points are mostly either trivial or solid gold, depending less on the wording of the treaties than on political goals. Does one want to push a treaty phrase flat against the last possible wall, or are we interested in working within what is virtually certain to be seen by other nations as the "spirit" of the law?

For example, contrary to Drexler, the fact that astronauts bring back a few kilos of moon rocks for scientific study does **not** create a precedent which requires all nations to cheerfully accept establishment of a moon-mining facility using millions of kilos for industrial purposes. There is much more involved here than a mere matter of scale, as Drexler suggests. The 1967 Outer Space Treaty clearly encourages scientific exploration in space. It also clearly, explicitly and repeatedly forbids "national appropriation" of space resources and insists upon use of space resources in ways which do not discriminate, so that all nations may benefit "irrespective of their degree of economic or scientific development." Nor is it likely that one could get other nations to accept the argument that a US (Govt. or private, or joint) strip mine on the moon to provide materials for a US space industry does not constitute "national appropriation." One need not plant flags and file claims to "appropriate" a resource. Consider: if you were an official or citizen of a rival or even doubtful nation, would you be willing to buy an argument like that? Since other nations are both judge and jury in deciding whether they'll accept some other nation's legal interpretation, I'm doubtful that well will many cases with such self-serving

Developing nations claim that as fellow human beings on our mother planet, they have a right to share in the benefits flowing from exploitation of a common property—the seabed or space. Drexler urges us to show that space exploitation actually increases access to resources and will be of great value for all nations. This is an excellent point, but the developing nations want a share of the benefits—be they resources, energy, or hard cash profits—and they want them guaranteed up front. Who can blame them? Many developing nations see exploitation of the seabed space as a dandy way for the rich to get relatively richer and the poor to stay poor. While Americans may not for a minute believe that the US is an imperialist colonialist exploiter, in many countries that merely proves that naive, self-serving, egotistical nature of the

The point then is that the US interpretation of international law is not and cannot be the only one, nor can it be enforced on other nations. We cannot avoid challenges if we act in ways which invite them, and it is reasonable to think that well get further and faster if we can mobilize a cooperative effort rather than trying to go it alone. For instance, Drexler makes an excellent political point when he proposes that the US accept some self-limiting resolution: a guarantee not to "appropriate" more than some very limited share of the resources of space for our exclusive use. If the potential of space is as large as we think, such self-limitation is relatively costless in any practical sense, immensely useful in a symbolic sense. That's the kind of appreciation of the political realities of international law which will help; an attempt to insist upon a rather transparently self-serving reading of the law will hurt. There's a "second law" in politics too: if we want something, we'll have to pay for it one way or another.

Jack Salmon
Williamsburg, VA

Eric Drexler's article in the April issue is an interesting interpretation of international law, but he fails to recognize the need for security of investment. Before a company invests in commercial exploitation of the moon, it must be assured that the developing countries will not invoke the principles expressed in the 1967 Space Treaty in an attempt to share in profits or even take over the facilities. Though no precedent exists for interpretations of the treaty which would require international agreements, only such agreements will assure the security of investments (short of war).

International conflict will undoubtedly arise if a US company begins mining the Moon. Perhaps this was an influential factor in NASA's decision to exclude the lunar resource idea. The fact that US and USSR missions returned lunar samples cannot justify unilateral exploitation of the Moon to the exclusion of developing nations in the face of such agreements as Articles I and II of the treaty. And withdrawal from the treaty is certainly no answer, for we then would be unable to demand compliance with other articles such as IV, which prohibits placement of weapons of mass destruction into space.

The developing nations are not asking us to save some for them, but they want to participate. If we agree that they have good reason to favor exploitation of space, why challenge them by doing it unilaterally? We should set up a private transnational corporation, or maybe a public multinational company, to begin space industrialization. Because this venture is in the interest of all countries, I believe international cooperation will be forthcoming—unlike the law of the sea convention. In fact, the establishment of a legal regime in outer space may set a precedent to finally settle the seabed conflict.

The proponents of a national approach appear to favor creating international conflict, in derogation of international principles and our own national policies, rather than cooperation.

Brian Maxwell
Tempe, AZ

Response to Responses to 'Space Mines'

by K. Eric Drexler

I share Jack Salmon's perceptions on the nature of international law (hence my statement that "... more than just signed treaties affects international relations," and my subsequent discussion of third world interests and positions), and thank him for his clear discussion of the basic concepts. As he points out, the issue is international politics, which flows from precedent, treaty, power, and perceived interests. Our greatest leverage at present is on the latter—which just happens to motivate the whole show. My point in discussing the 1967 Outer Space Treaty was not to show that it (or anything else!) can "require all nations to cheerfully accept establishment of a moon-mining facility", but to show that, contrary to the impression many have gained from past discussions of space law, the U.S. has not yet signed away its right of access to a share of space resources. Salmon seems to agree that the treaty has many possible interpretations (I will refrain from a second round of nit-picking on possible meanings of "national appropriation"), and that nations will follow their interests. We must recognize, however, that other nations do not yet *understand* their true interest in space, any more than does our own. This was the thrust of the latter part of my article, with which Salmon appears to agree.

Brian Maxwell fails to recognize that I recognize the need for security of investment. Again, the topic is vast, and my article was short. Multi-national corporations may well represent a viable approach, and should receive further attention.

Michael Michaud discusses a draft agreement deserving great attention from those interested in our future in space. It is explicit where the 1967 treaty is not. By denying property rights in extra-terrestrial materials, this agreement would discourage space colonization. Further, it would apply the undefined concept "common heritage of mankind" to space resources in the very midst of a battle over the same concept as applied to the seabed—and, as I have argued, the seabed makes a very poor analogy to space.

An agreement intended to divide supposedly scarce resources among the nations of Earth will be bad law if the real problem is speedy exploitation of unlimited resources and eventual division of the solar system among the people of space. An agreement made today would necessarily be the work of blind people; an agreement made in the future could be a working constitution for humanity in space. Those interested in a decent future in space should work to delay sweeping agreements of this sort until such time as the world better understands the significance—for everyone's sake.

Precis of the Article in 17 Col. J. Transnational Law 67 (1978) on "DOMICILE AND INDUSTRY IN OUTER SPACE"

by J. Henry Glazer

The flight of the space shuttle constitutes the first step for introducing in space a far-flung, yet totally interdependent, "system of artifacts" leading ultimately to space industrialization and human settlement. To achieve these ends people will be obliged to use space as a permanent place of abode (domicile) and not merely as a medium for transient voyages.

The article explores whether the existing state-centric system of international law is flexible enough to accommodate people as domiciliaries in outer space or whether drastic departure from the present system—such as "World Government" as suggested in an early study by NASA's Marshall Space Flight Center—would be a necessary concomitant. The research points out that the four existing Space Treaties are not geared to the regulation of interdependent "systems of artifacts" in space. Nonetheless, the paper suggests that the present state-centric orientation of international law is not only flexible enough to accommodate people as space domiciliaries but also furnishes an optimum format for space settlement.

These near-term legal events must be addressed immediately by the proponents of space settlement, or contemporary treaty-making could hobble, if not pre-empt, the future of space settlement itself.

As supported by precedents in international law and by the other sources which have been cited in the footnote material, the following conclusions have emerged from this study. All are of novel impression in the research literature.

1. World Government is not the *sine qua non* of space settlement. In fact, the opposite is true. The present state-centric system of international law, if it endures for the next hundred years, should ensure that a

healthy variety of entities, both public and private including profit-making, will have a hand in the venture. Their involvement portends that political power during early or beginning states of space settlement will not be monolithically centralized.

2. The imminent negotiation of a Moon Treaty, and increasing international regulation of the geostationary orbit, are near-term legal events which will affect substantially the future of space settlement. However, international conferences and draft treaty texts concerning the Moon and the geostationary orbit are oriented to resource allocation for States on Earth, and do not take into account in any degree space settlement and the future priority needs of space settlers for such natural resources. These near-term legal events must be addressed immediately by the proponents of space settlement, or contemporary treaty-making could hobble, if not pre-empt, the future of space settlement itself. One approach might be for private proponents to seek collectively so-called "Non-governmental Organization" status under the United Nations Charter, in order to ensure that a proper flow of expert information takes place on international as well as domestic levels.

3. Space law in its present posture deals with "space objects" and lunar-emplaced facilities in an isolated or limited context. It is not responsive in identifying a usable legal regime applicable to a far-flung, yet totally interdependent, "system of artifacts" essential for space settlement—ranging from habitats at the Lagrangian points, to a Moon-based mass driver, to PowerSats in geostationary orbit, and to the various spacecraft derived from shuttle geometries which are to service all these. Future space treaties which elaborate the status of objects in space and permanent facilities constructed on celestial bodies, should be oriented toward a "systems approach" in the regulation of all such artifacts, and not deal with each category in an isolated context.

4. Both the technical and legal regimes of re-usable Earth-to-Space Transport systems (the Shuttle) are moored, and will remain moored, to aeronautical experience. In marked contrast, the technical and legal regimes of intraspace transport (carriage of goods and persons in space alone) will tend to follow maritime experience. With respect to intraspace transport, this study has furnished to the research community the legal concept of "Space Cabotage" (a concept derived from Maritime Law) which is defined as follows:

> **Space Cabotage:** "Means navigation between points in space including those on or above celestial bodies other than Earth by spacecraft neither designed nor intended for flight or passage in or through terrestrial airspace."

Of all of the legal and technical regimes in space the future one of "Space Cabotage" is most susceptible to exploitation by private enterprise with minimal public regulation or interference.

5. The study is one of only a few in the legal literature dealing with the question of human rights and fundamental freedoms in the context of space settlement. Treaty-criteria for emigrant selection are also proposed as well as it common working language for space. Adverting to legal precedents in treaty law and in the law of diplomatic relations the paper proposes that French be adopted for this purpose.

6. On the matter of space settlement, presentations to the Congress of the United States and to others have tended to focus upon engineering and "hard sciences" aspects, together with the enormous costs involved. It might be wise, however, to investigate in greater depth and to furnish the Congress and others with reports focusing upon the inexpensive "soft science" problems bound up in space settlement research such as those concerned with the rational extension into outer space of human rights and fundamental freedoms; operational roles for private enterprise in the system of artifacts essential for future space settlement; juridical modeling for solar power delivery; the tree City approach to space settlement in lieu of sovereign entities: the dangers of negotiating a Moon treaty, at this time, without taking into account the priority needs of space settlement and Spacekind. The "Million Dollar Research Grant" is clearly not essential to explore, and to resolve, these important questions, all of which are as central to space settlement as the engineering and "hard sciences" necessary to bring it about.

Epilogue to "Domicile and Industry in Outer Space":

SOME REFLECTIONS BEYOND THE CITY IN SPACE

by J. Henry Glazer

For some, the *sine qua non* of space settlement is world government, an ideal which ignores completely the pluralistic quality of the international community with its almost universal consensus against any drift toward a monolithic planetary Earth State. For others, neither the existing nor future political alignment of the planet will be of any importance when tested against the scientific postulate that space settlement must inevitably produce a sense of cosmic "apartheid" so total in separating humankind and the space descendants they will spawn that each will be obliged to treat the other as an alien life form.

The purpose of this investigation was not to assail these positions. The results, however, tend to support the conclusion that the impact of such positions upon space treaty-making at the key international conferences remaining in the Twentieth Century *is destined to be imperceptible.* Thus, it will continue to fall to the orthodox space jurists with their positivist doctrine to shoulder the essential burden of formulating defensible models for space settlement.

The narrow object of this investigation focused initially on whether a person as a domiciliary, and not just a transient voyager, could be accommodated in space without frontal assault on the state-centric system of international law. In concluding that this was possible, a funny thing happened, however, on the way through the Free City of Danzig' to the Free City of Lagrangia, precipitated by one of the strangest paradoxes of the Twentieth' Century. The paradox is that good can come out of evil and evil out of good, and that:

"The 'goodness' in 20th-century

> thought was the burgeoning idea of unity of peoples as exemplified first in the League of Nations and then in the United Nations. The 'badness' was seen in the residual 'tribalism' of people that separated one group from another out of pride, or fear, or envy, or contempt. In the modern world such tribalism takes national form."[2]

By some strange dint of irony it seems to have been the backward-looking person with his primitive sense of homeland rather than the forward-looking cosmopolite with loyalty to none who has managed to impede and even check the march of murderous despots from Austerlitz to Auschwitz—thereby proving anew, and for all the wrong reasons, that in history "goodness" and badness are inextricably intertwined.

In the milieu of space settlement, "goodness" for space jurist and Star-Trek aficionado alike seems to be institutionalized in the personage of the future space inhabitant as agent and cosmic envoy for a collective humankind while "badness" remains lodged in the virulent tribalism which remains rife and abroad on the planet. To a limited extent, and doubtless unwittingly, the scientific literature on space settlement contributes to this fund of "goodness" by sheltering humankind's envoys in a "space *colony", a* term which, for the juridical purist at least, conjures up the image in space of a dependent political community tied to some future single Earth-State, yet to be established, whose benevolent (or oppressive) writ extends to every area of our planet and to all people both on and off of it. The "bad" derived from all of this "good" is that such a colony would not merely become a clone-colony of the Earth-State, but perhaps a clod-colony reflecting in its peoples all of the leveling of national diversity and elimination of differences digested in the giant maw of some cylindrical or Torus-like Orwellian nightmare.

For the Western-style democracy in retreat before contingents of gun-toting rulers, dictators, and presidents for life, each with the latest U.N. anti-Zionist resolution in hand, a certain allure must persist for the preservation of the state-centric system of international law and the *rational* perpetuation in outer space of the wide diversity which it is bound to engender. In the paradox of "goodness" and "badness," however, the counter argument seems irresistible that it is precisely this diversity, precisely this "tribalism", which has caused for millenia all the war and misery afflicting planet Earth and human condition. The potency of that counter argument cannot be met save by hopeful speculation which focuses upon the conceptual differences between sets of treaty obligations in space as opposed to those on Earth.

Of the four conventions which exist for space, one is dedicated in its entirety to the rescue and return of persons and space objects. On Earth, SALT talks continue to generate proposed texts for terrestrial disarmament treaties, but in space the *prevention of armament treaty* has managed to make its debut and with it another chance for all of us.[3]

If these distinctions are lost upon statespeople, they may still be of some currency to the writer of science fiction weaving a plot around a powerful cultural taboo in space against force of arms—its primeval source, in Twentieth Century treaty-making, lost forever in aeons of time which in their passage witnessed the settlement of the entire solar system by a kind and congenitally nostalgic Homo alterios.[4]

> So it was that in a demonstration of Spain's imperial power to the innocent natives of the New World, the cannon from NINA, with PINTA standing by, poured roundshot into the shipwrecked SANTA MARIA the day after New Year's 1493,[5] while separated from that event, through a millenium of time and space, not one among the sixteen-thousand member expeditionary force of officers and crew sent in the star ships ATHENS, DANZIG, and LAGRANGIA to terraform the lifeless planets of Barnard's Star had ever fired, had ever seen, or had ever known of, a military weapon.

References

1. The Free City of Danzig, unique in the annals of international law, was established after World War I under the provisions of the Treaty of Versailles as a less-than-fully sovereign community. Human rights and fundamental freedoms were secured to the Free City's inhabitants by an unusual melding of treaty law and local municipal law with disputes resolved from time to time through the advisory opinion process of the Permanent Court of International Justice at The Hague. The author concludes that the treaty model for the Free City of Danzig can serve as a precedent for the establishment by treaty of Free Cities in Space.
2. "The Intertwining of Good and Bad", Chicago Daily News, October 29, 1976. Reprinted by permission of Sydney J. Harris and Field Newspaper Syndicate.
3. Significantly the Antarctic Treaty, the Seabed Demilitarization Treaty, and the Space Treaties contain the common theme of "prevention of armament" in those places.
4. In his book **Living in Outer Space,** the commentator, Robinson, suggests that the physical and psychological characteristics of space settlement are bound to produce in future generations a being in space, "Homo alterios", whose value-forming processes differ in kind, rather than degree, from those of his Earthbound ancestor, Homo sapiens.
5. This description of Columbus' departure from the New World homeward bound for Spain is reported in Morison, **The European Discovery of America,** 81 (Oxford Univ. Press 1974).

Space Habitat Class Offered

It is interesting to note island societies are considered as peaceful and contained, while frontier societies are considered lawless and aggressive. Will space settlements be the frontier? Will they be islands? How might they perceive the Earth, and each other?

These and other questions will be taken up in a new University of Massachusetts/Amherst course titled "Environmental Concerns, Earth Habitat/Space Settlement," to be offered this fall at the Orchard Hill Residential College.

The course, listed as Orchard Hill 290E, examines the concepts of space settlements, addresses the issues implicit in the design and building of systems which support large numbers of humans, and then looks at the actions we may take in managing or mismanaging our earthly habitats.

Based upon two books; **Colonies in Space** by T.A. Heppenheimer, and **Earth Habitat/Space Settlement**, by J. W. Stryker, the course is taught at two levels; a popular or overview suitable for freshmen and sophomores in any discipline, and at a rigorous level suitable for juniors and seniors in environmental science, physics, engineering and the biological sciences.

Topics covered are: the mathematics and physics of space settlements and the earth habitat; energy and resource management; human factors and human values; pollution and health; ecosystems, classical terrestrial and hypothetical ecosystems suitable for space settlements; and applications of high technology to solve environmental problems.

Thoreau said 125 years ago, "What use is a house if you haven't got a tolerable planet to put it on?" This course addresses the problems of making both Earth habitats and space settlements liveable, hospitable, and humane.

For more information, contact Orchard Hill Residential College, 413/545-2882.

Inside the L-5 Society

L-5 SOCIETY, INC.

REVENUE
AND EXPENSE STATEMENT
July 1, 1977 - April 30, 1978

REVENUE	
Membership Fees & Donations	$47,318.83
Sales	18,450.96
Misc.	14.61
TOTAL REVENUE	$65,784.40
EXPENSE	
L-5 News, Mailing, & Purchases	$32,716.41
Operating Expense	29,704.71
TOTAL EXPENSE	$62,421.12
NET OPERATING SURPLUS	$ 3,363.28

Annual Elections

The annual election of the L-5 Society Board of Directors has arrived. Please detach this ballot and mail it back in the attached envelope. We request that you sign the ballot envelope.

The ballot lists all candidates for the Board which received approval from the Nominating Committee. Its members were Carol Motts, Conrad Schneiker, John W. Braue III, H. Keith Henson and Barbara Marx Hubbard.

You can vote for as many Directors as you wish, including write-in votes. Not voting for a candidate is equivalent to voting against him or her as each candidate must receive votes in excess of half the total number of ballots cast in order to be elected.

The Nominating Committee recommends that you vote for all candidates listed. They are recommended on the basis of their work towards the goal of having tens of thousands of people living and working in space by the end of this century. They have all taken an active interest in the work of the L-5 Society.

What is the job of the Directors? They are responsible for setting policy and controlling expenditures of the Society. They are the guardians of the interests of the members.

Also on the ballot are some bylaws changes. They have been drawn up in response to recommendations the US Chamber of Commerce has provided for associations.

The annual meeting will be held July 15th at 2 PM in the L-5 office at 1060 E. Elm, Tucson, Arizona. At the meeting ballots will be validated and counted. (We are waiting that long because experience tells us some of you will once again receive the **L-5 News** late. If it hasn't arrived by June 26th, please complain to your local post office and also to us and we will file another complaint.)

Bylaws Changes

I do ___ do not ___ approve all the proposed changes.

(If you do not approve all the proposed changes, please check which of those below you approve. *Please remember, failure to vote for bylaws changes is equivalent to voting against them.)*

The L-5 Society Board of Directors has proposed the following changes and additions to the Society bylaws:

Article VII: Officers

___Section 1. Officers of the organization shall be a President, Secretary and Treasurer, and Coordinators as needed and authorized by the Board of Directors. As soon as practical after the Annual Meeting and election of the Board, The Board shall nominate and by majority secret ballot elect from the members of the Board the Officers. Each Officer's term of office shall be coterminous with and dependent upon each Officer's tenure as a member of the Board, except that a retiring Officer shall continue to serve until replaced by the new Board.

___Section 2. Officers who resign or otherwise vacate their position may be replaced by the Board, using the procedure in Article VI, Section 2 above.

Article VIII: Duties of the Officers

___Section 1. President. The President shall preside at membership meetings. The President shall have charge of the business of the organization and shall administer all affairs of the organization in accordance with the Charter and these Bylaws, and shall act as official spokesperson of the Society, but in all cases the President shall be bound by the policy established by the Annual Meetings and the Board of Directors. The President shall sign all contracts, appoint the Chair of all committees responsible to the President, and may sit as an ex officio member of all committees.

The President may, with approval of the Board of Directors, hire and appoint an Executive Director, to whom may be delegated operational responsibility for such duties as may be appropriate.

(Note: this material would replace the current Art. VIII-1, thereby deleting most references to Coordinators. Since the original assumption about the role of Coordinators has not been fulfilled, this seems appropriate. Art VIII-4 still allows appointment of Coordinators for special projects. The provision for an Executive Director is new.)

___Section 2. The Secretary shall maintain records of the proceedings of all meetings and shall discharge such other functions as the President or the Board shall direct. The Secretary shall carry out official correspondence, preserve written records (except financial records), keep the membership roll, provide notice of meetings of the Board or the Society, and shall receive, verify and record all votes of the Board or Annual meeting. The Secretary shall have charge of maintaining and supplying copies of the Charter, these Bylaws, and other official papers of the Society.

Article X

___Section 4. Voting shall be by mail or secret ballot. Each ballot shall be returned to the Secretary, who shall certify the election of each person who shall obtain a majority of votes from among those voting.

Section 5. The President shall cause to be announced in the next available issue of the Society Newsletter the names of such persons as are elected to the Board.

Article IV. Dues and Assessments.

Section 1. Delete Section I and replace with "The annual dues for each member of the L-5 Society shall be determined by the Board of Directors."

Under our present bylaws, a small group can pack the Annual or a special meeting and take action damaging to the Society. We propose renumbering Article V, Section 5 to Section 6 and inserting:

___"Section 5. The authority to approve policy positions, statements on behalf of the L-5 Society, and institution of new programs shall be reserved to the Board of Directors."

___It may be wise to require Board approval of bylaw changes, in -addition to the presently required 2/3 of members' votes. Hence, we propose that Article XI, Part A be amended to read "Approval by majority vote of a quorum of Directors at any meeting of the Board of Directors."

We propose amending Article X, Section 3 to delete "The number of Directors to be elected will be determined by majority vote of the Board of Directors." Also, we propose adding: "Section 7. A special election to elect additional members to the Board of Directors may be called at any time by majority vote of a quorum of the Board of Directors."

Article XII - Indemnification

__"The L-5 Society, by resolution of the Board of Directors, provides for indemnification by the association of any and all of its Directors or officers or former Directors or officers against expenses actually and necessarily incurred by them in connection with the defense of any action, suit, or proceeding, in which they or any of them are made parties, or a party, by reason of having been Directors or officers of the L-5 Society except in relation to matters as to which such director or officer or former director or officer shall be adjudged in such action, suit, or proceeding to be liable for negligence or misconduct in the performance of duty and to such matters as shall be settled by agreement predicated on the existence of such liability for negligence or misconduct."

If we are sincere about our goal of "to disband, in a mass meeting, at L-5" (Sept. 1975 **L-5 News**) we should include:

Article XIII—Dissolution

__The L-5 Society shall use its funds only to accomplish the objectives and purposes specified in these bylaws, and no part of said funds shall inure, or be distributed, to the members of the L-5 Society. On dissolution of the L-5 Society any funds remaining shall be distributed to one or more regularly organized and qualified charitable, educational, scientific, or philanthropic organizations to be selected by the Board of Directors."

(Please check the candidates you wish to elect to the L-5 Board of Directors.)

____Isaac Asimov—He is a science writer whose articles on space settlements have appeared in publications ranging from **National Geographic** to the **Saturday Review** to **Fantasy & Science Fiction.**

____Senator Barry Goldwater, Sr.—He was one of the first members of Congress to support both solar power satellites and space settlements.

____Robert A. Heinlein—He is a science fiction writer; his books such as **The Man Who Sold the Moon** and **The Moon Is a Harsh Mistress** foresaw many of the issues which are now a matter of serious international debate.

____Gordon R. Woodcock—He is Boeing's solar power satellite study manager.

____Barbara Marx Hubbard—She chairs the International Committee for the Future. She was one of the earliest financial supporters of space settlements research, and was responsible for framing House Concurrent Resolution 451.

____Hon. Edward R. Finch, Jr.—He is Chairman of the American Bar Association Aerospace Law Committee.

____Arthur Kantrowitz—He is Director of Research at Avco-Everett Labs and one of the world's foremost experts on lasers.

____Philip K. Chapman—A scientist/astronaut, he was responsible for crew training and coordination for the Apollo 14 mission in 1970. He is an advisor to the Earthport project and currently works for Arthur D. Little, Inc. on solar power satellites.

____Norie Huddle—She is an environmentalist and author of **Island of Dreams,** a chronicle of the environmental crisis in Japan.

____Harlan Smith—He is head of the Astronomy Department at the University of Texas in Austin and Director of McDonald Observatory.

____Konrad K. Dannenberg—He is a veteran of Peenemunde, former project director of the Jupiter missile system and deputy manager of the Saturn Program.

____J. Peter Vajk—He is a space industrialization researcher for Science Applications, Inc.

____Jack D. Salmon—He is a professor in the Department of Political Science at Virginia Polytechnic Institute and State University.

____H. Keith Henson—He is president of Analog Precision, Inc. and a space industrialization researcher. He was the first president of the L-5 Society.

____Carolyn Meinel Henson—She is the editor of the **L-5 News** and current president of the L-5 Society.

____William Weigle—He has been the treasurer of the L-5 Society since it was founded in 1975.

____Phillip Parker—He has been the President of the West European Branch of the L-5 Society since 1975.

____Mark Hopkins—He is a researcher with Rand Corporation.

Write-in votes:

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BY LAWS

Article I

The name of this organization shall be the L-5 Society.

Article II

The purposes for which the Corporation is formed are to operate exclusively for charitable and educational purposes, namely to promote space colonization. In furtherance of these goals the corporation may:

A.
1. Educate the public with technical and general information.
2. Conduct research.
3. Fund research by others on solar energy, space colonization and related areas.
4. Prepare models for use in space and participate in their use.
5. Carry out other activities in furtherance of these goals.

B. In order to carry out and achieve the foregoing purposes the Corporation may:
1. Receive, hold, administer, lend and expend funds and property.
2. Make contracts.
3. Solicit, collect, receive, acquire, expend, invest and lend money and property, both real and personal, received by gift, contribution, bequest or otherwise.
4. Sell and convert property, both real and personal into cash.
5. Use the funds of the Corporation for any of the purposes for which this corporation is formed.
6. Purchase or acquire, hold, use, sell, exchange, assign, convey, lease or otherwise dispose of and mortgage, or encumber real and personal property.
7. Borrow money with or without security and to incur indebtedness and secure the repayment of the same by mortgage, pledge, or deed of trust on real property or personal property of the Corporation.

C. The foregoing statement of purpose shall be construed as a statement of purposes and powers and the purposes and powers in each clause shall be regarded as independent purposes and powers.

Notwithstanding any of the above statements of purposes and powers, this Corporation shall not engage in activities which in themselves are not in furtherance of the charitable and educational purposes set forth in paragraph A of this article.

Article III

Membership

Section 1. Regular membership in the organization shall consist of all who are willing to serve, attend meetings of the membership, vote, and who have contributed dues for the current year.

Section 2. Student membership in the organization shall be limited to those who are enrolled in a recognized academic institution and shall be entitled to all the privileges and prerogatives of regular members.

Section 3. Institutional membership in this organization is open to all organizations and corporations. Institutional members shall be entitled to all of the privileges and prerogatives of regular members, except that they may not vote at elections, hold elective office in the organization or act as chairman of a standing committee.

Section 4: Non-members may attend and participate in all open meetings, social gatherings, and any regular activities of the organization, except that they shall not have a vote in any decisions, and may be required to contribute their fair share toward any expense incurred through such participation.

Section 5. The powers of the members of this organization shall be limited to those usually held by stockholders of a commercial corporation, as such powers may be further limited by the Laws of Arizona and the U.S.A. for members of a non-profit corporation.

Article IV

Dues and Assessments

Section 1. Each regular member shall pay dues of $20.00 per individual or per family per year, $10.00 per student. Institutional members shall pay dues of $100.00 per organization per year. (Minor children of all members may participate in all educational and social activities of the organization.) Dues shall be payable to the Treasurer on the first month that they begin to receive the newsletter and become delinquent on the 30th day of the month in the following year. Suspension of membership shall be automatic if dues are not paid within thirty days. A member may be re-instated upon payment of current dues.

Section 2. There shall be no general or special assessment levied against the membership, unless approved by a two-thirds (2/3) vote of all members after discussion at a duly constituted meeting. This provision, however, shall not prevent any member or group of members from making voluntary donations to the organization for the support of specific projects.

Article V

Meetings of Members

Section 1. There shall be at least one (1) regular business meeting of the membership each year, which will be the Annual Election meeting. Special meetings of the membership may be called at any time by concurrence of at least three members of the Board of Directors. The Secretary shall notify members by mail of the time and place of each meeting, at least two weeks in advance. Such meetings may be conducted by mail or by phone.

Section 2. Business of the organization may be transacted at any meeting attended by not less than three members, hereinafter called a quorum, of the Board of Directors. This meeting may be held over the telephone or by mail, with all decisions mailed to the three or more Board Members at that meeting for majority vote in order to be valid.

Section 3. A simple majority vote of a quorum shall decide all issues calling for a vote, unless a greater number shall be required by law or these by-laws. Only paid-up members shall be entitled to vote at these meetings, and each member shall have only one (1) vote on each issue. Votes for amendment of the By-laws or Annual Elections, and upon demand by any member, the vote on any other question before the meeting, shall be by written secret ballot. Members may vote by U.S. Mail and members shall not be required to be present at any meeting to vote thereon provided notice is given to each member and such notice included full particulars of the nature and extent of the issue to be voted on.

Section 4. The rules contained in Robert's Rules of Order, Revised shall govern all meetings of the organization in all cases where applicable and not inconsistent with these By-laws.

Section 5. The decisions reached by duly constituted meetings of the membership shall be binding upon the Board of Directors and shall be executed by the officers to the best of their ability. No member or group of members other than said Directors or Officers shall approach any outside organization or act as representative of the organization without the prior approval and authorization of the Board of Directors granted at a regular or special meeting of said Board.

Article VI

Board of Directors

Section 1. The Board of Directors shall consist of at least five qualified members of the organization who are duly nominated and elected to Directorship by the members at large at an annual election as hereinafter provided. The term of office shall be one (1) year, beginning with the Annual Meeting.

Section 2. Any vacancy on the Board occurring through death, resignation, disqualification, or any other cause, may be filled for the unexpired term by an affirmative vote of the majority of a quorum of the remaining directors.

Section 3. A board member may be removed for just cause by a majority of the Board.

Section 4. The Directors shall meet whenever required, at the time and place or by telephone or mail upon written or telephoned request of three or more of the elected officers. Verbal notification to all Board members may be given in any manner necessary to assemble a quorum.

Section 5. Any three (3) members of the Board of Directors shall constitute a quorum for the transaction of the business of the Board.

Section 6. The business of the Board of Directors shall be conducted in such order as the Board may from time to time determine by resolution.

Section 7. The Board of Directors shall have the management and control of the operation of the organization. The Board may exercise all of the powers of the organization, and do all such lawful acts as it deems necessary of the membership as prescribed by these By-laws and the laws of the State of Arizona and the U.S.A.

Article VII

Officers

Section 1. The Officers of the organization shall be Coordinators as needed and authorized by the, Board of Directors, Secretary, and Treasurer. At the Annual Meeting, and immediately following the election of directors, the newly elected Board of Directors shall nominate and by majority secret ballot, elect from the members of that Board the Officers. The term of office of each officer shall be coexistent with and dependent upon each officer's tenure as a member of that Board of Directors. The newly elected officers shall be installed at the end of the Annual Meeting.

Article VIII

Duties of Officers

Section 1. Coordinators. The Coordinators shall choose one of their numbers to preside at any given meeting of the membership and the Board of Directors, that person not necessarily being the same for all meetings. That person shall have general charge of the business of the organization discussed in that meeting and shall administer all affairs of the organization in reference to business done at that meeting subject to the direction of the Board. That person shall be responsible for implementing Board action to carry out all general policies and projects established by vote of the membership at that meeting. That person shall sign all contracts duly entered into by the organization after approval by the Board of Directors at that meeting. That person shall appoint the chairpeople of standing committees related to these activities and special committees and sit as an ex-officio member of such committees when expedient. These Coordinators shall call regular and special meetings of the membership of the Board of Directors as required, and instruct the Secretary to notify members thereof. In the absence of the Secretary, the Coordinators will appoint a Secretary Protem. In this manner different Board members will be able to take responsibility for different projects or duties.

Section **2.** Secretary. The Secretary shall be present at and record the proceedings of all meetings of the organization and of the Board of Directors. That person shall be responsible under the Coordinators for all official correspondence for the organization and shall preserve all written records, except financial records, of the organization. The Secretary shall keep a roll of all members, and shall receive, verify, and record all absentee ballots or proxy votes. That person shall give reasonable written notice of all meetings to the members thereof, and prior to each meeting shall inform the Presiding Officer of any correspondence or unfinished business to be transacted, and verify that a quorum is present. The Secretary shall keep available to all members of the organization copies of the Constitution and these By-Laws, including all amendments thereto.

Section 3. Treasurer. The Treasurer shall receive, record, and safeguard all monies paid into the organization, including collection of dues. That person shall keep full and accurate books of account for all financial transactions of the organization, and shall render a financial report when called upon by the Board of Directors or the membership. That person shall open the books for inspection at any time deemed necessary or desirable by the Board of the membership. The Treasurer shall pay all bills duly approved by the Board of Directors. The Treasurer shall prepare and present to the Board of Directors an Annual Financial Report, covering all transactions for the calendar year, July 1 through June 30. The Treasurer shall inform the Secretary of all new memberships and dues paid, as needed.

Section 4. Coordinators. They shall be chosen by majority vote of the Board of Directors to head up specific projects as needed.

Section 5. All correspondence, conveyances, encumbrances, releases, discharges, contracts, or obligations of the organization, of every nature and description, shall be executed or countersigned by the President, unless the Board of Directors otherwise directs.

Section 6. Local Chapters. The Board of Directors of the L-5 Society shall recognize any local chapter that has at least one member of the L-5 Society in it and whose activities are in agreement with the Articles of Incorporation and the By-Laws of the Society. Local chapters may include members who are not members of the L-5 Society. Each local chapter shall elect a President, Secretary, and Treasurer. The Secretary of the local chapter shall be responsible for keeping the L-5 Society informed of the local chapter's activities. The Treasurer shall provide the parent organization with the financial records of the local organization when requested by the Board of Directors. Local chapters shall have the right to establish additional by-laws regarding their chapter, providing that the by-laws do not conflict with the By-Laws or Articles of Incorporation of the L-5 Society. The local chapters shall have the right to determine how locally raised money is to be used, providing that its use does not conflict with the By-Laws or Articles of Incorporation of the L-5 Society. The L-5 Society shall, upon request of any of its members, provide the names and addresses of the nearest local chapters. The tax status of the L-5 Society shall also cover the local chapters which are recognized by the Board of Directors. If the Board finds that a local chapter has engaged in activities in violation of the By-Laws or Articles of Incorporation of the L-5 Society, it shall revoke its recognition of the local chapter. Any local chapter which is not recognized by the L-5 Society shall not fall under the tax status of the Society, nor shall the Society be held responsible for its actions.

Article IX

Expenditures

Section 1. All proposed expenditures up to and including $500 may be approved by the Coordinators responsible. All proposed expenditures exceeding $500.00 shall be approved by the Board of Directors prior to actual disbursement.

Section **2.** All expenditures are subject to review by the Board of Directors at any meeting.

Section 3. The Board of Directors is responsible for maintaining appropriate records to account for all property purchases for or owned by the organization.

Article X

Annual Elections

Section 1. At least one month prior to the Annual Meeting, the Board shall appoint a nominating committee, at least three of whom are not current members of the Board of Directors.

Section 2. Not less than one week prior to the Annual Meeting, the Chairperson of the nominating committee will provide the Secretary with the names of the selected nominees, and the Secretary will notify the membership of the time and place for the meeting, and the names of all current Directors and nominees.

Section 3. At the Annual Meeting, the Chairman of the nominating committee shall place in nomination the slate of candidates selected. Thereafter, the membership at large may make additional nominations from the floor, and the Secretary shall place in nomination any names proposed by absentee ballot. All such nominees who do not personally decline shall comprise the slate of candidates for election to the Board of Directors. The number of Directors to be elected will be determined by majority vote of members.

Section 4. Voting shall be by written secret ballot. Each ballot shall be filled in with as many names of the voters' choice as desired up to the previously voted upon limit. The nominating committee shall tabulate the ballots, including absentee ballots, in the presence of the membership. All candidates receiving the vote of a majority of members voting in the election shall be elected Directors.

Section 5. The election results shall be confirmed and announced by the presiding officer at the Annual Meeting. That person will preside as chairperson protem while the newly elected Board of Directors shall immediately elect from among themselves the new officers of the organization. The new Officers shall be announced and installed before the end of the Annual Meeting, and serve from that date.

Section 6. The Annual Meeting will be held in June, or earlier if decided by a majority vote of the Board.

Article XI

Amendment of By-Laws

The By-Laws of this organization may be adopted, amended, or rescinded in whole or in part by a three-stage procedure as follows:

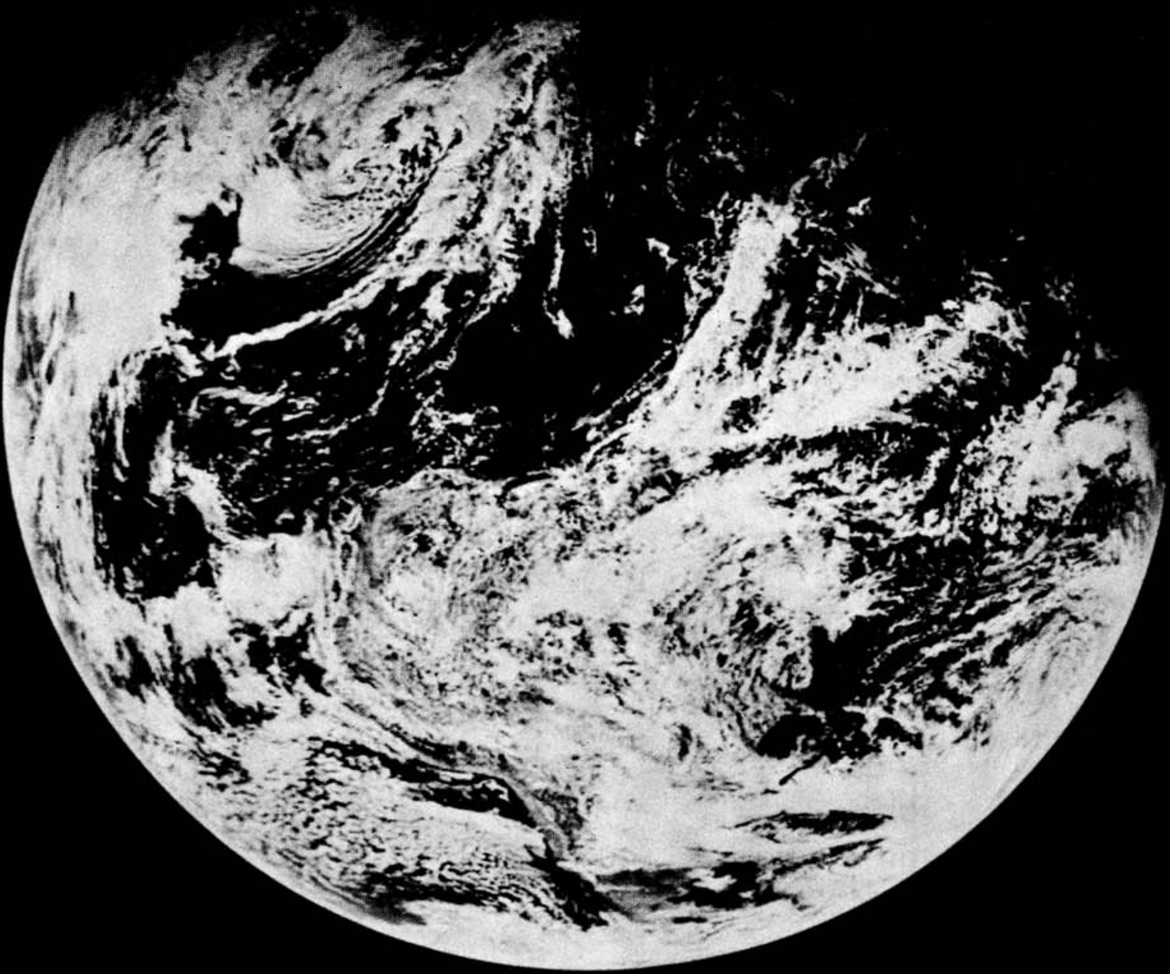
A. Approval by majority vote of a quorum of members at any duly constituted regular or special meeting of the membership, or by majority vote of a quorum of Directors at any meeting of the Board of Directors.

B. Publication by U.S. Mail to all current members, of the intention to make, amend, or rescind the By-Laws, with a brief outline of the proposed changes, and notice of time and place for a regular or special meeting of the membership to vote on the proposed changes.

C. Final approval by a two-thirds (2/3) majority vote of a quorum of members present at a duly constituted meeting of the membership, to be held not less than one month following notification as required above or by two-thirds (2/3) vote of those responding by mail if the vote is held by mail.

L5 NEWS

July 1978



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Eric Drexler, Editor

Membership Services:
Janet Tarney
Chris Naliwsky

William Weigle,
Administrative Services

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*Mark **Hopkins***
*Norie **Huddle***
Magoroh Maruyama
Harlan Smith
Carol Motts

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Membership Services: L-5 Society, 1620 N. Park Avenue, Tucson, Arizona 85719. Telephone: 602/622-6351.

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L-5 Society
Membership Services
1620 N. Park
Tucson, AZ 85719

In this issue:

1 **The New Space Program: Conflict, Cooperation and Common Interest** *Former O'Neill research assistant Eric Drexler proposes ethical standards for space researchers.*

Flippo Bill Passes House

2 **Suppose Isabella Had Said "No"?** *Robert G. Nichols draws some historical parallels.*

3 **Space Habitats By Accident?**

SPS Promoted to DOE Back-Burner

People in Space—An ESA European Viewpoint *Phill Parker reports.*

4 **A Social Psychologist Looks at the Space Program** *By Charles J. Divine*

5 **Boeing, ADL Outline SPS Development Plans** *Eric Drexler wraps up the aerospace "party line" on SPS.*

7 **Offshore Satellite Solar Power Receiver Studied** *Tom Bros describes an SPS receiver design that may meet even the most stringent environmental limits.*

8 **Laser Propulsion to Geosynchronous Orbit** *Eric Drexler reveals the just-declassified details of a bold new propulsion system.*

9 **Bibliography Update** *By Conrad Schneiker.*

13 **Sun Day** *Peter Mikes, Ken McCormick and Carolyn Henson discuss Sun Day activities, held May 3.*

14 **Inside the L-5 Society**

17 **Letters**

Editor's Note: I would like to thank frequent **L-5 News** contributor Eric Drexler for holding down the editor's desk this month. His work allowed me to take a much appreciated rest after the birth of my third child, Valerie Aurora, June 8. I'll be back on the editor's job with the next issue. —*Carolyn Henson, President, L-5 Society.*

Cover: The planet Earth, showing North and South America.

THE NEW SPACE PROGRAM: *Conflict, Cooperation, and Common Interest*

by Eric Drexler

Because you are a member of the New Space Program community, you share strong common interests with everyone who supports a goal of the New Space Program. The New Space Program community needs a better understanding of itself and of its common interests if it is to act effectively on the national political scene.

Recent years have seen the growth of renewed support for space, but with a new set of goals. The old space program had three sides: human exploration, automated probes, and useful satellites. Of these, the first has died, the second has languished, and the third has passed on into the realm of the accepted and routine. The New Space Program (NSP) has three major sides as well: space industrialization, satellite solar power, and space colonization. Like the old space program, with its human exploration vs. automated probes conflict, the NSP has its warring factions. Fortunately (considering the sorry state of funding for the old space program), enlightened self-interest provides grounds for greater cooperation among us.

The goals of the NSP require large-scale space operations. To support any goal of the NSP is to have an interest in better lift vehicles, large space structures, power systems, orbit transfer vehicles, teleoperators, space stations, solar furnace/antenna surface configuration technology, knowledge of human physiology in space, knowledge of materials processing in space, and so on down an endless list of space-related knowledge and capabilities. *Common technologies create powerful common interests within the NSP community.*

The goals of the NSP require public and political support for space. To support any goal of the NSP is to have an interest in a public perception of space capabilities as a desirable national goal, and of space activities as an important part of our future. Such a public perception, together with more direct political pressure, will help increase federal support for space research and activities, will encourage the US to negotiate favorable treaties, and will result in a more favorable situation in the federal bureaucracies. Since "space" is to a large extent a single category in the public mind, *a common political environment creates powerful common interests within the NSP community.*

Despite these common technical and political interests and the limited cooperation they have produced, a corrosive atmosphere of conflict pervades the New Space Program community. Supporters of differing NSP goals and means to goals (i.e., the ground-launched approach to SPS, the space manufacturing facility approach to SPS, etc.) commonly object to each other's efforts for one or more of the following reasons:

1) The goal advocated is too far-out to be credible to anyone (or to Congress, or to conservative engineers in related fields, or whatever), and hence advocacy of the goal discredits the space program and my project.

2) The means advocated for reaching a legitimate goal are too far out, or are inferior to my proposal, and should be eliminated from further consideration or greatly de-emphasized.

3) Money is scarce, and my project deserves the lion's share of it.

For these reasons, planetary scientists (eyeing space manufacturing as a justification for planetary exploration) have claimed that *only* space manufacturing can make SPS a viable concept, SPS advocates have claimed that space colonies are not feasible this century, space manufacturing advocates have played up the possible environmental hazards of launching SPS systems with big boosters, and supporters of more modest space efforts have called for more caution lest the public find itself disappointed. In articles, lectures, and congressional testimony, spokespeople for various camps have failed to support each other's goals, have emphasized the cost of technologies required for other's proposals, have taken pains to disassociate themselves from other groups (even those working for broadly similar goals), have joked about other's goals, and have used other proposals as scapegoats when their own proposal comes under criticism. These efforts have

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FLIPPO BILL PASSES HOUSE

After many postponements, HR 12505 came to a vote on the floor of the House Thursday, June 22, in the late afternoon. It passed, 267 to 96. While this large margin should help smooth its future course, the end is not yet in sight.

In the House, it must now pass the Appropriations Subcommittee on HUD-Independent Agencies, chaired by Rep. Howard Boland (D-MA). Its prospects in this subcommittee seem bright, as Boland voted "aye" on the floor. In light of his previous opposition to many of NASA's planned projects, supporters of SPS owe Boland a hearty "thank you".

Progress in the Senate seems less certain. Senator John Melcher (D-MT) introduced S 2860 (the Senate version of HR 12505) last May, but hearings have not yet been scheduled. Owing to a backlog of work, Melcher expects hearings to be held no earlier than late July, shortening the time available to complete the legislative process in this session.

If passed, the Flippo bill will provide \$25 million for SPS research in fiscal 1979, permitting vitally needed technology verification and development work, as well as a closer examination of SPS environmental impacts.

not noticeably increased anyone's funding, nor have they furthered development of lift vehicles, large space structures, power systems, and so on. They have even poisoned the atmosphere for the constructive technical criticism required to improve or weed out poor ideas. In short, everyone loses.

Is there a way everyone could win? Is there a way of looking at the New Space Program which would encourage more cooperation and less destructive forms of competition? Let us consider the sources of conflict, and possible ways of reducing it.

First, should the NSP have fewer goals? Fewer goals would decrease the range of support. Would lessened interest in space colonies increase support for SPS? I think not. Would lessened interest in SPS increase support for space colonies? Certainly not! Is the SPS a credible goal? Congress seems to think so. Are space colonies a credible goal? The only serious question is *when* — fifteen years, fifty years, or a century. Since space colonies have generated vigorous grass-roots support for SPS and space industrialization, advocates of the latter would seem ill-advised to spend effort attacking the former. Indeed, it is hard to conceive of a ground-launched SPS program, with the cheap space transportation it implies, not eventually leading to a growing space population, better space living facilities, and exploitation of space materials. In short, all our goals are credible, and all our goals help gather support: *diverse goals strengthen the New Space Program.*

Second, should fewer competing means be proposed to achieve these goals? Fewer means, like fewer redundant systems, would decrease the chance of reaching our goals, and would weaken our case for development of the technology base common to all large-scale space enterprises. So long as technical criticism weeds out worthless proposals, *competing means strengthen the New Space Program.*

Third, is destructive competition an effective way to help one's project? Advanced space planning is a minute sliver of the federal budget, and hence is elastic. At best, elimination of a competitor might slightly increase the funds available for other work — while crippling the case for the NSP as a whole. More realistically, *attempts* at destroying a competitor result in counterattack, weakening of both sides, and even greater losses to the NSP. Benefits from destructive competition range from small to negative.

In light of our technical and political common interests, and of the strength inherent in diverse goals and competing options, and of the futility of attempting to destroy the competition, cooperation would seem advisable. A few suggestions:

1) Project a positive attitude towards the whole range of NSP goals. After all, are space industrialization, solar power satellites, or space colonies actually bad ideas? Have any of them been shown to be impossible?

2) Support further study of all viable concepts. This will cost little at present, will encourage others to return the favor by supporting study of your concept, and besides — what better way to uncover the flaws in your competitor's ideas?

3) Make sure the flaws in your competitor's concept are studied, by supplying technical criticism — preferably in technical circles rather than before congressional committees.

4) Be open about uncertainties and difficulties both for credibility's sake and as reasons for further study.

5) Discourage NSP community members from destructive behavior by friendly-but-critical phone calls and letters in response to harmful public statements.

In his congressional testimony of April 14, Dr. Peter Glaser sets a good example:

"The SPS development program will focus development efforts on space processing, fabrication, assembly and maintenance; human habitations in orbit; space transportation efficiency, and the need for future exploitation of extraterrestrial resources, thus setting the stage for achievements which may transcend anything that heretofore has been accomplished by the human species."

If we recognize our common interests and interact more constructively, the NSP community will become more unified and more effective. Together, we have considerable credibility and political power. Together, we can bring the New Space Program into the national arena, defend it successfully, and set this country back on the road to space.

Suppose Isabella Had Said "No"?

by Robert G. Nichols

"Suppose Isabella had said'NO'", reads the caption on the poster hanging over my desk. The poster shows an illustration of the Moon behind Saturn V at liftoff. Beneath these is a drawing of Columbus' three ships at sea.

Well, what would have happened had the Genoese navigator failed to pursuade Queen Isabella to finance his expedition to what he thought would be China and India? Obviously history would be changed, but in the long run its course would have been similar.

At the end of the 15th century, the Renaissance was rapidly spreading from Italy to the rest of Europe. European traders were bringing back treasures from the East: Spices, cloth and wonderous works of art, as well as Eastern sciences, mathematics and philosophy. The European universities were quick to assimilate the new sciences and information, including a bit of knowledge handed down from the early Greeks: The Earth is round.

Christopher Columbus must have been exposed to this information while studying to be a navigator. His idea that the Orient could be reached by sailing west was in no way unique. It was an idea whose time had come. Columbus was simply the first navigator of repute who managed to fit out an expedition to prove it.

If Columbus had failed to acquire the needed funds, if Isabella had said "NO", then history would credit another navigator with the discovery of the New World. He might have been from another country but he would have been armed with the same information.

The poster over my desk draws the analogy between Spain financing Columbus's expedition and the U.S. funding NASA's space exploration. Spain reaped immeasurable riches from Columbus' and subsequent travels to the New World. The U.S. has the opportunity to gain immeasurable benefits from its space program. Only a few of these benefits have been realized but others will soon be evident. Space industrialization, the next step in this nation's space efforts, will offer us myriad products, processes and services. The construction of powersats will reduce, if not eliminate, this nation's dependence of foreign oil. Telesats could make the term "global village" a reality.

There are signs, however, that the U.S. may be terminating its all-out support of the space program. NASA's funds have been cut repeatedly.

It is as if Queen Isabella, having seen its riches, discontinued expeditions to the New World. If Spain had ended such exploration, other nations would have taken the lead. The Portuguese, the Dutch, the British—all would have exploited the riches on the western side of the Atlantic, leaving the dregs and castoffs to Spain.

In a like manner, should the U.S. reduce its efforts toward space industrialization, others will press on. Already the U.S.S.R. has many more successful launches than the U.S. The Russians have built a space station where they are currently conducting research into space manufacturing. Great Britain, France, West Germany and Japan all have active space programs. A private firm, OTRAG, has built a space port in Zaire. They claim to be able to deliver a payload into orbit more cheaply than the space shuttle.

If the U.S. decides to cut back its space program, space industrialization will be carried on by others. It might take longer, but the "Third Industrial Revolution" will occur. Americans will simply enjoy less of the benefits.

Suppose Isabella *had* said "NO." Well, Europe would still have found its way to the New World. But the people of Mexico might be speaking Dutch instead of Spanish.

SPACE HABITATS BY ACCIDENT?

Speaking at the 1978 Robert H. Goddard Memorial dinner in Washington, D.C. in March, Dr. Hans Mark, Under Secretary for the Air Force, offered his views on the future of space exploration.

Keyed to the year 2000, Mark believed by that date "normal" people will have flown in space, pointing out that as many as a hundred people sitting in a future Goddard dinner will have partaken in orbital flight.

Also by 2000, space will include permanent residents but, emphasized Mark, it would not take place by the popular O'Neill concept. "It will happen by accident," felt Mark, believing that maintenance stations will provide a service to repair and replace earth-assisting application spacecraft. "The friendly telephone repair man will be there," and as space living conditions improve, such repair men "will volunteer for extra duty" concluded Mark.

Expanding his presentation to include the entire universe, Mark stressed that "a new horizon of knowledge will be created" producing "a new feeling about ourselves". The possible understanding of such cosmic wonders as neutron stars, black holes, quasars and the properties of matter will lead to a unified field theory Mark felt, which in turn will create an "intellectual revolution of our understanding of planet Earth in the universe".

SPS PROMOTED TO DOE BACK-BURNER

by Eric Drexler

Yes, the SPS has been moved up onto the back-burner from the dust behind the stove DOE established an SPS program office last April, and now has an SPS group at Argonne National Laboratory, in Argonne, Illinois. Further, DOE now has plans to supplement its previous "SPS Concept Development and Evaluation Plan".

This plan calls for DOE to spend $3,341,000 on environmental impact studies, socioeconomic impact studies, and comparisons with other energy systems during fiscal '79, while NASA spends $1,300,000 on system definition studies. In fiscal '80, DOE funding and NASA funding are to **drop,** by $714,000 and $500,000 respectively. No money is to be spent on space-related technology work, which most researchers consider a high priority.

DOE now plans to request an addition of unknown size to the 1980 budget for what they call Ground Based Exploratory Research, apparently to be spent primarily for evaluation of microwave effects. One source in DOE states that this request was sent to OMB in late May; another states that it will not be ready until October.

In response to questioning, one source in DOE stated that the Flippo bill funds would be useful for getting long-term environmental studies under way — "if OMB will let us spend it" — while another stated that the Flippo bill was "premature," and that microwave effects should be studied in great depth before even beginning to develop and test SPS technology. Opinion in DOE has it that evaluation of the chronic effects (if any) of low-level microwave exposure will require 20 years.

People in Space—An ESA European Viewpoint

by Phillip J. Parker

With the United States busily preparing its Space Shuttle vehicle for the beginning of a new era in space activities in the 1980's and the Soviet Union increasing the pace of its spaceflight programme towards permanently staffed space stations, I recently questioned officials of the European Space Agency (ESA) on how they foresaw European activity in the sphere of human spaceflight and in the wider overarching concept of space industrialisation.

For about one year, ESA has been actively defining the possible elements to an extension of the present Spacelab reusable space laboratory (which ESA is producing as Europe's contribution to the USA's Space Transportation System) that might possibly lead to a contribution to space stations. As a first near-term step, shortcomings of the present Spacelab design could be removed, including giving higher power to the Spacelab payload, extending mission duration beyond seven days and including selected improvements in certain subsystem areas. A second and third Spacelab follow-on development step could foresee contributions towards a power module — which is beginning to figure increasingly in NASA studies of future space station steps. The Spacelab would be made compatible with the power module with respect to interfaces, particularly concerning higher power levels and heat rejection. Mission duration capability would be increased and steps initiated to make Spacelab more autonomous from the Shuttle Orbiter. This might include, for example, the deployment of Spacelab pallets from the Orbiter and their attachment to the Power Module

A fourth step under consideration could be the deployment of the Spacelab module and to intoduce either intermittently or permanently operations in connection with the Power Module. The last far-term step under consideration is the applicability of Spacelab as an element of Space Stations. Further options under discussion are the contribution of solar arrays to the Power Module (if built by NASA), mission-dedicated Spacelabs (e.g. materials processing, life sciences), and further co-operation with NASA in its studies of space stations.

A Social Psychologist Looks at the Space Program

by Charles J. Divine

I would like to discuss some reasons why the space program has seen opposition in recent years. An understanding of past objections may help us understand objections to the new proposals for space. I also plan to explore, briefly, the impact upon humanity these new ideas may have.

Many people oppose these proposals on grounds that they are impossible (Senator Proxmire described them as a "nutty fantasy"). Remarkably new ideas have been greeted in similar fashion in the past. The first steamboat was called "Fulton's folly." The purchase of Alaska was called "Seward's folly." Thomas Hobbs predicted disaster for the new democracy of the United States. Late in the nineteenth century, physicists predicted little future development for their science (a noted British physicist, Lord Kelvin, remarked "The future of physics lies in the tenth decimal place."). It took three years for the Wright brothers to win recognition for their efforts. Recently I read in a newspaper that Japan abandoned work in nuclear weapons during 1943 after concluding that such weapons could not be developed before the end of the war. The people who voiced these opinions were neither foolish nor incompetent; their reasons were frequently well thought out. The success of the seemingly impossible was rooted not in the conventional ideas of the time but in a new set of ideas which extended human knowledge.

Other problems confront these new proposals for space development. Supporters of the space program have justified it in terms of international politics, scientific exploration or as a grand adventure for humanity (or at least a few humans). People have thus come to see the space program as an expenditure of our wealth and, to many, an extremely ill advised one at that. As an example of this attitude when I started to bring up these ideas with an acquaintance, her first remark was "I don't want to hear about it. People are starving and we can't afford that space nonsense." She didn't even want to listen to an idea which could greatly benefit the world's starving millions, because it was a "space" program.

Further contributing to the wasteful image of our space program is its exposure. Our space program has been carried out in full view of the world. Its successes, failures and costs have been widely reported. This stands in great contrast to, for example, the development of the modern computer, which was developed in private laboratories at private expense and given to the world in already useable form. When a computer breaks in a lab, it requires specialized instruments to detect it. When a rocket blows up on a launch pad, a child can tell something has gone wrong.

A further difficulty of the space program is the long time required to develop any new technology. With much of the development visible to the general public, this creates problems. A space scientist or engineer cannot work quietly in the laboratory and present his results as if by magic, hence progress seems comparatively slow.

Also increasing the impact of cost is the fact that the government spends our tax dollars on space research but does not directly reap the benefits thereof, as a corporation reaps benefits from its research expenditures. This not only makes calculating the relation between cost and benefit more difficult, but also tends to destroy the link between the two in the average person's mind.

Adding to this problem is the lack of full awareness by the public of the benefits already obtained from the space program. Rockwell International's *Why Space is Important to Our Future* is quite informative in this regard; I learned a great deal from it.

Regarding this impact of space on public thinking, there are important reasons for supporting House Concurrent Resolution 451. In recent years we have heard much talk about the limits of our world and how these limits will adversely affect our democratic society. Work on space industrialization and settlement will demonstrate the fundamental shortcoming of *The Limits of Growth:* Forrester's model ignores technological innovation. Vajk (1976) and Boyd (1972), by incorporating technological change in their model, arrive at results quite the opposite of Forrester's.

As a social psychologist, I have become concerned about the society proposed by many limits of growth advocates. Their proposals seem to regard democracy and individual freedom as incompatible with survival. Research in social psychology, as reported in Kelley and Thibaut (1969) and Gibb (1969), seems to indicate that democratic organization styles, with great individual freedom, are considerably more effective in solving complex problems, such as those encountered in developing technology. Seeming to bear out this analysis are the numerous difficulties encountered by the Soviet Union in recent years by its failure to develop, or even effectively use, modern technology. It would thus seem that by limiting freedom and weakening democracy, the limits of growth advocates might produce the failures they seek to avoid.

It would seem that a determined attack upon some of our problems could also give American society a vitality which has been missing in recent years. We seem beset by a wide variety of intractable problems--energy, unemployment, poverty, pollution. By attacking these problems in a forthright, imaginative manner we may restore the hope any society needs to function well and thus turn our society around.

Such an effort would also remind people that ofttimes many attempts are required before success is obtained, but when success is reached, it can repay all the failures many times over. Columbus' voyage to the Americas was not the first--many preceded him. But his voyage served to open up the Western hemisphere to the Eastern and led to vast benefits for Europe.

In this essay I have briefly indicated why we should support this new work in space. I have also attempted to deal with some of the objections raised in the past to such work. If you would like to discuss these ideas in greater detail or at more length, please contact me.

Charles J. Divine
214 Park Lane
Trenton, NJ 08609

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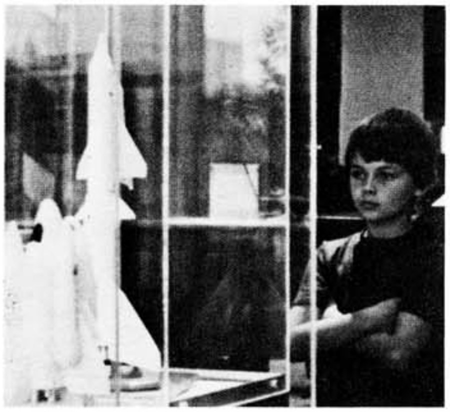


BOEING, ADL OUTLINE SPS DEVELOPMENT PLANS

by Eric Drexler

On April 13 and 14, O. C. Boileau, President of Boeing Aerospace Company, and Dr. Peter Glaser, Vice President of Arthur D. Little, Inc. testified before subcommittees of the House Committee on Science and Technology in support of the Solar Power Satellite Research, Development, and Demonstration Act of 1978---the Flippo bill. Their testimony gives us a picture of what a vigorous SPS development program should include, and discusses some of the less obvious benefits of such a program.

The supplement to Boileau's statement begins by pointing out that the U.S. spent roughly $200 billion on energy last year, and that of this sum $45 billion went overseas to purchase oil. It argues that a domestically controllable, non-depletable source of energy is vital to U.S. economic stability. Of the many energy alternatives that have been discussed, only fusion reactors, breeder reactors, and SPS are continuously available, non-depletable, non-regional sources of electric power. He points out that nuclear power research receives about one billion dollars per year, as compared to about five million for SPS —a factor of 200.

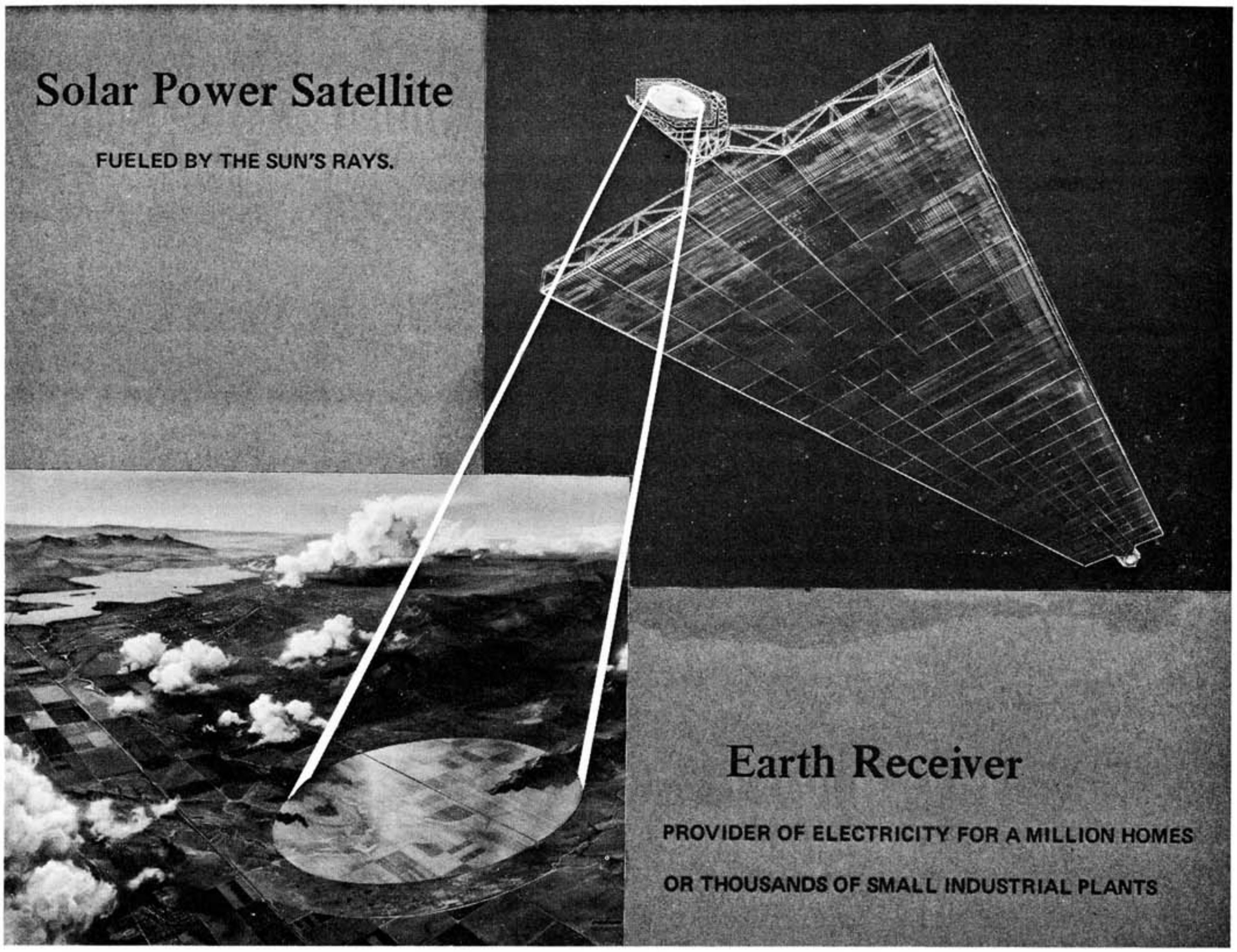
Reviewing past research, Boileau concludes that studies have shown SPS technology to be feasible, and that remaining questions revolve around cost reduction and a better understanding of system impacts. To answer these questions, Boeing proposes a three-phase technology developement and verification program, consisting of:

---Ground-based technology verification
---Flight tests
---Technology verification power unit

For the first, Boeing details a five-year, $173 million program ($25 million in the first year, as provided for in the Flippo bill) to develop and test solar cells, materials, structures, thermal engines and systems, power distribution controls, microwave power transmission systems, flight control systems, space construction operations, and space environmental effects.

Following and overlapping this, they propose some seven years of flight tests for technology verification, starting in 1980. This would include $50 to $100 million for a microwave interferometer experiment, some $675 million for shuttle sorties, and $2.1 billion for a power system test bed unit in low orbit, assuming the preceeding work gives favorable results.

To test the effects of long-term microwave exposure in an inexpensive manner, they propose to string microwave oven amplitrons over four acres of ground,


Solar Power Satellite
FUELED BY THE SUN'S RAYS.
Earth Receiver
PROVIDER OF ELECTRICITY FOR A MILLION HOMES
OR THOUSANDS OF SMALL INDUSTRIAL PLANTS

providing space for a variety of plants, animals, and types of land-use. A similar, adjacent piece of land would be prepared as a control.

Dr. Glaser's testimony begins by briefly discussing the technical merits of the SPS, then cites Dr. Frank Press, White House science advisor, as saying that high technology industries in general have shown almost three times the growth rate, twice the productivity increase, nine times the employment growth rate, and only one sixth the price increase of low technology industries. He further points out that SPS provides the best of both worlds, in that its high technology side is complemented by its need for employment-generating mass production of components. In addition, SPS could make the U.S. an energy exporting nation, helping to reverse the drain on our balance of payments.

After reviewing past work on the SPS, Glaser concludes that the technology to build them exists, and that risk analysis and prospects for economic viability justify proceeding with the next phase of development. He believes the Flippo bill would provide a vital supplement to the existing study program, permitting the terrestrial tests and space experiments needed to advance the credibility of the SPS concept. He outlines a development program consisting of three overlapping phases: concept feasibility studies (in progress since 1972), technology advancement, and demonstration projects. For the second phase, he proposes a five-year program with a total cost of $200 million---roughly 10% of the funding for advanced nuclear energy options.

Dr. Glaser then discusses some long-term implications and short-term benefits:

"Although studies to date have indicated that the SPS may indeed be one of the most promising options for generating electrical power which could be available in the post-1990 period, it would be premature to propose today a national commitment to actual deployment and operation of the system on a scale commensurate with energy needs. All that is needed now is a limited development program, as discussed above, aimed at resolving those outstanding issues which will determine the eventual priority to be given the SPS in the overall national energy plan.

"In addition to providing the information needed for timely decision, this program could contribute significantly to the achievement of much more immediate policy goals. Even in its early phases, a serious study of the SPS would be a most dramatic energy initiative. Unlike other energy R&D efforts, the SPS development program would capitalize on the international prestige generated by very successful U.S. space programs, especially Apollo. Although the scale of the SPS challenges the imagination, few will doubt the technical capability of this nation to deploy such systems in orbit. Like Apollo, the SPS is a major technological enterprise which can fire the spirits of people everywhere, engage international participation and cooperation, and, if it is successful, provide a powerful stimulus to economic growth, here and abroad. It is not a panacea, but it does offer a combination of desirable characteristics unmatched by any other proposed energy source.

"Because of these factors, a development program of the type envisioned in HR10601 could yield these short-term benefits:

(i) *Slowing oil price inflation*

By giving notice to oil supplying nations that a viable and significant alternative to dependence on oil was under investigation, the SPS development program could lead to some restraint in continued escalation of the world oil price. It should be noted that the cost to this nation of imported oil is such that deferment of an annual increase of only 0.1% (or about a penny per barrel) would pay for the program proposed here.

(ii) *Changing public perceptions of the future*

Because of its dramatic character and profound implications, the SPS development program can help engender positive attitudes towards the future in a way that could not be expected from, say, a commitment to coal gasification. In particular, it could modify the common opinion that nothing much is being done about the energy crisis. Moreover, a prerequisite for deployment of the SPS is development of a truly economical capability for transportation to orbit and for large-scale construction in space: the possibility therefore arises of other forms of space industrialization and, eventually, of human settlement off Earth. The consequences for the future of man may include the indefinite postponement of limits imposed by terrestrial resource exhaustion. Even in its early stages, the SPS program may thus help the current gloom and restore the classic American confidence in the future. Like Apollo, the SPS can serve the social purpose of "getting this country moving again"; but, unlike Apollo, the program can be justified in quite pragmatic terms.

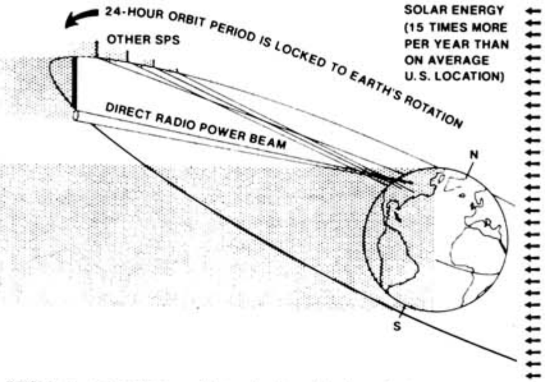
"It is difficult to quantify these types of benefits. But it is clear that they may be sufficient to justify the level of funding I have proposed for the next several years, even without regard to the longer-term promise of the SPS. However, these benefits can accrue only if the SPS program is credible: it must be funded at a sufficient level to demonstrate convincingly that this is a serious program. Present expenditures, approximating one percent of the total DOE solar energy budget, or of the budgets for other advanced energy sources, cannot be expected to achieve these goals."

Dr. Glaser's testimony concludes by discussing the goals of the Sunsat Energy Council (see "Sunsat Energy Council Formed," April **L-5 News**).

His testimony is particularly noteworthy for its support of a wide range of space goals, including industrialization, habitation, and mining. Such actions help to build a sense of community and common interest among supporters of these goals, which in turn will aid us in becoming a more effective political force (see "The New Space Program: Conflict, Cooperation, and Common Interest," in this issue).

Supporters of the SPS could build an even stronger sense of common interest by planning to devote a few percent of SPS funds to studies of how and when non-terrestrial materials should be phased into SPS production. NASA finds such studies credible (see "Lunar Resources Study Underway,"May **L-5 News**), as does Congress (see "High Frontier Bill Introduced," April **L-5 News**). In addition to broadening the base of support for SPS funding and providing the overall proposal with more flexibility, such an action would increase one of the short-term benefits of the SPS program cited by Dr. Glaser: it would help in changing public perceptions of the future for the better. ☐

Stationary earth orbit location is sunlit over 99% of the year.


24-HOUR ORBIT PERIOD IS LOCKED TO EARTH'S ROTATION
OTHER SPS
SOLAR ENERGY (15 TIMES MORE PER YEAR THAN ON AVERAGE U.S. LOCATION)
DIRECT RADIO POWER BEAM
N
S

SPS is a solar dam Once built no further fuel is required

Offshore Satellite Solar Power Receiver Studied

by Tom Brosz

An offshore structures division of a major Texas corporation is studying a proposal suggesting the possibility of constructing an offshore antenna to receive energy from solar power satellites and deliver it to coastal cities.

The solar power satellite system uses a large satellite placed in an orbit which makes it appear to remain over a single position on the earth's surface. This satellite collects energy from the sun night and day, and transmits the energy in the form of a tight microwave beam to a point below it on the earth.

The microwaves are collected by a large receiving antenna on the ground, and converted into electricity for use.

The ground receiving antenna is a flat surfaced array which is spread over several square miles to intercept as much of the microwave beam as possible. Some designs cover a roughly circular area 7 kilometers across.

Despite the enormous size of the antenna, it is actually quite lightweight. The antenna surface is made up of receiving elements placed half a wavelength of microwaves apart (about 10 cm.). This grid of elements receives the microwaves, converts it to electricity, rectifies it to DC power, and funnels it into transmission lines. This grid intercepts almost all of the microwaves, allowing very little to strike the ground below the antenna. However, the grid allows most of the normal sunlight and rainfall through its chicken wire-like structure.

The efficiency of the system can approach nearly 100% in conversion, and the large area of the antenna permits leftover heat to be slowly released into the air around it. Hence, very little thermal pollution results.

The major problem with the antenna system has been locating the system far enough from major useful areas so as not to use up valuable landscape, yet have it close enough to the electrical customers to reduce the length of energy-wasting transmission lines.

The offshore structures division feels that one answer may be to locate the receiving antenna in shallow water offshore from coastal cities. Landspace would then be located close to the users of the electrical power.

Since most coastal cities are major shipping ports, the antenna would either have to be placed out of shipping lanes (difficult with such a large object) or built on high supporting towers to allow ships to pass along underneath. The height and width of the largest ship required to pass under the structure's "roof" would dictate the major dimensions of the antenna. This extra height would also keep the antenna clear of high waves and most spray, although the operation of the antenna is only slightly hampered by rain and moisture.

Initial designs show the flat antenna array supported on a field of towers resembling those used in oil well platforms, and using similar structural techniques to anchor them to the shallow bottom of the coastal sea. Heavy structure is required to protect the antenna from damage during high winds, common in southern and eastern U.S. coastal waters.

Studies will need to be made to research effects, if any, on shallow water wildlife and fishing. The antenna itself would seem to have little effect, as mentioned earlier, and the tower structures may even enhance sea life by providing shelter for fish and plants in the manner of natural reefs. If the structure is placed so as to be between the coastal cities and the prevailing direction of storm activity, it may even be possible that wind and wave action could be reduced by the maze of towers and antenna structure. This could result in reduced damage from frequent tropical storms.

The flaw in the offshore system would appear to be costs. A land-based antenna would have to be placed in remote areas of little used land, but would require much smaller supporting structures since it need be placed only a few feet off the ground.

Ships do not need to pass underneath (though automobiles might), and it does not need to resist oceanic winds and waves. A land-based stucture would be built on the much cheaper principle of a chain-link fence rather than an oil-well platform. This cost must be balanced against the increased costs of the land-based system's need for much longer transmission lines to the power users. Transmission costs may be reduced somewhat by using DC transmission, though installation costs would not be greatly improved.

Other cost factors to be examined:

- increased fishing production due to "artificial reefs" of offshore antenna support towers
- possible use of support towers for oil drilling structures beneath the antenna's shielding effect, saving money on platform construction
- increased shipping costs due to having to pass through the rows of towers parallel to the rows instead of making a passage along a possibly shorter route through the area.
- Decreases in efficiency of microwave transmission due to passage through moister ocean air rather than dry, clear air over land-based system (usually assumed to be in some type of desert area due to criteria of low land value)

It is likely that costs not involving the antenna, such as launch costs and construction costs for the power satellite itself, will be nearly identical for both offshore and land antenna systems.

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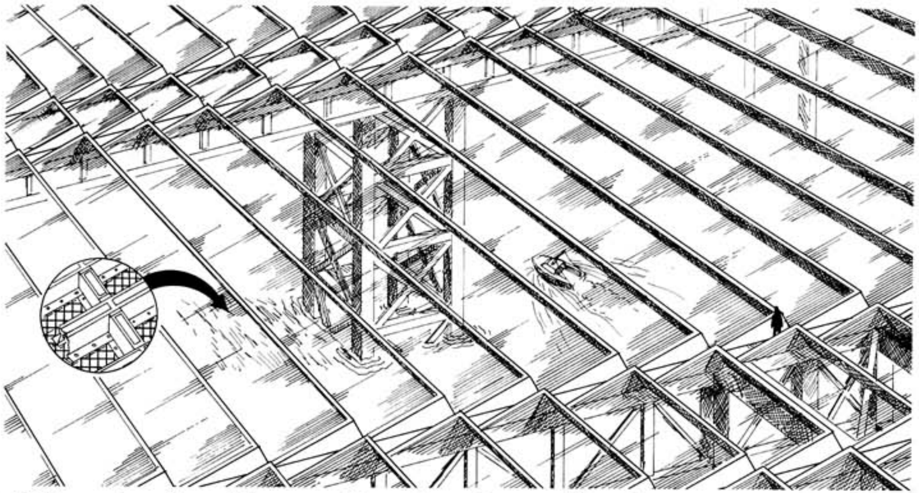


A bird's-eye view of an offshore receiving antenna for a satellite solar power system. Detail shows enclosure for electronic components which turn microwaves into electrical energy. "Chickenwire" grid prevents microwaves from passing through the rectenna.

Laser Propulsion to Geosynchronous Orbit

by Eric Drexler

The laser propulsion concept, developed by Arthur Kantrowitz, chairman of AVCO Everett Research Laboratory, offers a promising alternative to chemical rockets as a means of getting off Earth. Although still in a very early stage of development, the outlines of a system concept have begun to firm up. The results are impressive.

Rockets work best when their exhaust velocity is not much less than the velocity they must reach. Unfortunately, the energy per unit mass available from chemical fuels limits the exhaust velocity of chemical rockets to about 4.5 kilometers/second, while the velocity they must reach to escape Earth or achieve a high orbit is about 11 kilometers/second. It is this mismatch between exhaust velocity and mission velocity that drives rocket designers to multiple stages containing vast amounts of fuel in the lightest possible tanks and structures. This, in turn, means large, expensive vehicles which are difficult to reuse. While chemicla rockets can be greatly improved through advanced designs (i.e., fully reusable shuttles and single-stage-to-orbit vehicles), alternatives seem worth considering.

Laser propulsion would sidestep the limits of chemical rockets by supplying power to the vehicle from a station on the ground. Laser heating of an inert propellant such as water can produce exhaust velocities around 8 kilometers/second, a good match to the task of carrying payloads (such as power satellite components) to geosynchronous orbit. This, in turn, cuts the ratio of propellant to payload, permits single-stage vehicles, and makes lightweight structures far less important.

The laser power needed to launch a vehicle into space scales directly with its mass, the ratio being approximately one billion watts (1 GW) per ton of payload. Since the cost of the system depends mainly on the laser power required, small vehicles seem best. Most studies have assumed a payload of one ton, about a thirtieth that of the shuttle.

Since infrared carbon dioxide lasers can be made roughly 20 to 30% efficient, a 1 GW laser will require around 4 GW of electric power and considerable cooling capacity (note power lines and pipes in figure 3). Reliability and ease of construction favor a bank of small lasers over a single big one. High-power laser development is classified, and the Department of Defense has not owned up to having a laser larger than 0.2 million watts (MW) — a development now quite a few years old. A declassified photograph of a large CO2 laser, together with standard scaling relationships, suggests that the U.S. now has lasers of some tens of MW, a quite adequate size.

The atmosphere poses problems to the propagation of laser beams, including absorption and thermal blooming. Both water and carbon dioxide absorb carbon dioxide laser light. To escape most of the former, the laser launching station would be located on a mountain top. The effects of the latter are reduced by elevation as well, but the phenomenon of atmospheric bleaching—momentarily saturating the absorbing CO2 with light so that it becomes transparent—helps even more.

Thermal blooming results when laser heating of the air makes it shift, destroying the focus of the beam by refraction. The Department of Defense has taken an interest in this problem, and workers in the field believe that it can be compensated for by use of actively controlled, flexible mirrors at the laser launching station. A good focus at a distance of 1000 kilometers and as much as 60 degrees from the zenith seems achievable.

The favored vehicle engine design involves a block of solid propellant (or a porous plate moistened with liquid propellant) surrounded by a short metal skirt (see figure 4). A weak laser pulse would vaporize a controlled amount of propellant, which would then expand in a fraction of a second into a layer about seven centimeters thick across the bottom of the vehicle. A powerful laser pulse would then heat the vapor to a high temperature, and the vapor would expand at high speed, giving the vehicle an impulse of thrust. The cycle would then repeat.

Such a vehicle could be quite cheap. Since the propellant tank (or block) is so small, it need not be designed to the absolute minimum weight — an automotive level of technology should suffice. Since many such vehicles would be needed, they would be built on an assembly line basis — again, very similar to automotive technology. If the electronics, sensors, pumps, and other valuable components were included in detachable reusable packages, one might readily believe the cost projection on the lower vehicle-cost line of figure 6: a mere $20/kilogram to geosynchronous orbit, for a traffic model typical of ground-launched SPS construction. This possibility makes laser propulsion well worth further investigation.

Laser propulsion work is still at a comparatively primitive stage of development. Calculations have been performed to answer most of the obvious questions, and experiments have been performed at the AVCO Everett Research Laboratory on small model engines. Classified work has apparently answered many of the questions relating to the laser and beam propagation. While NASA has virtually

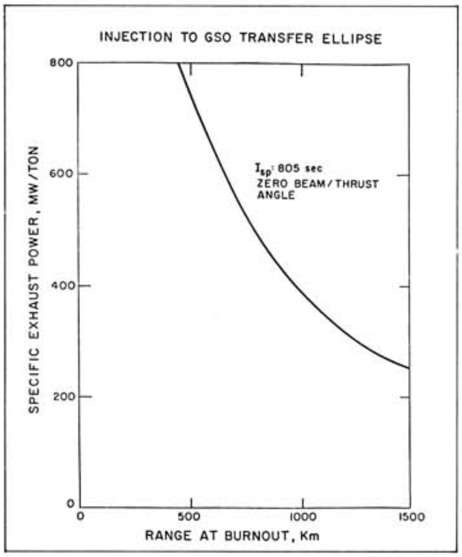


Figure 1

The exhaust power per unit burnout mass necessary to inject a single stage vehicle into a geosynchronous transfer ellipse is shown.[1,2]

Launch from earth at a °60 angle from the zenith is assumed. Less power is needed if the laser can accelerate the vehicle over longer ranges, but this requires better optics and/or a larger (and hence higher drag) receiver on the rocket.

The necessary laser size is obtained by multiplying the curve by the desired mass injected into orbit and dividing by the product of the internal efficiency of the engine times the atmospheric transmission (typically 0.8 to 0.9).

Circularization of the orbit at apogee could be accomplished with a solid propellant rocket to give the necessary 1.7 km/sec velocity increment. However, this reduces the payload by about a factor of two. Alternately, a relay mirror at geosynchronous orbit would be used for laser propelled circularization, which would give a post burn mass of approximately 80% the apogee mass

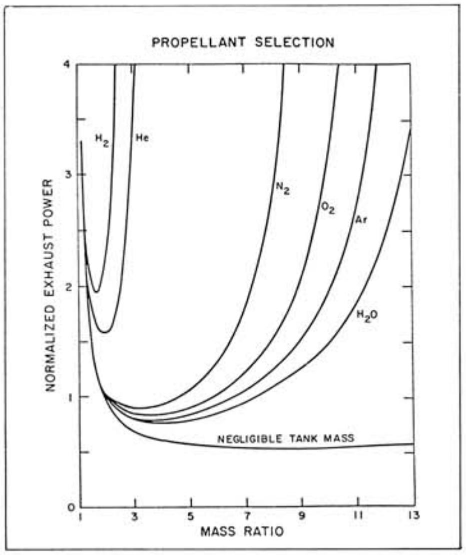


Figure 2

Laser Propulsion allows selection of propellant on bases other than specific enthalpy. Since the capital cost of the lasers tends to dominate the economics of laser propulsion, it is desirable to minimize the laser power necessary to launch a given mass. Hydrogen and helium are poor choices due to their low density and the consequent weight of the tankage. Water gives good results with a mass ratio (initial mass/burnout mass) of five. This corresponds to the velocity ratio approximately 1.6 (final vehicle velocity/exhaust velocity) that gives the best propulsive efficiency, i.e. minimum energy expenditures. Argon is also a reasonable choice, and its use might minimize atmospheric pollution effects.

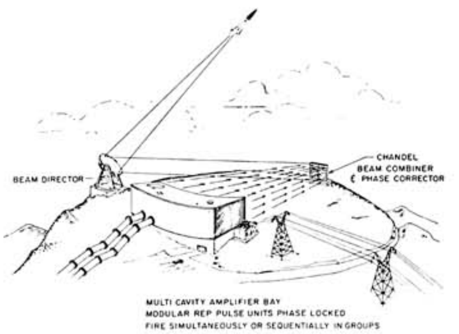
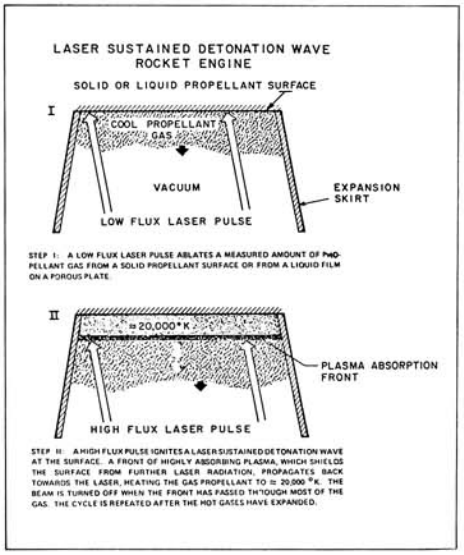

BEAM DIRECTOR
CHANDEL
BEAM COMBINER
& PHASE CORRECTOR
MULTI CAVITY AMPLIFIER BAY
MODULAR REP PULSE UNITS PHASE LOCKED
FIRE SIMULTANEOUSLY OR SEQUENTIALLY IN GROUPS

Figure 3

A gigawatt laser facility for laser propulsion could be constructed by combining the beams from a number of laser cavities. The converging beams would be rendered parallel to each other by a multifaceted element, the "chandel." Temporal coherence between the different beams is assured by using a single oscillator laser which drives a branching chain of amplifiers. Alternately a number of oscillators could be phase locked by injection of a signal, strong compared to spontaneous emission, derived from a single master oscillator. The spatial phase front is adjusted to give a diffraction limited beam at the rocket. Compensation is made for thermal blooming and inaccuracies in the beam director by adjusting the chandel elements or by introducing phase compensation in each laser. Signals for these corrections would be obtained by optical feedback from the rocket.



STEP I: A LOW FLUX LASER PULSE ABLATES A MEASURED AMOUNT OF PRO-PELLANT GAS FROM A SOLID PROPELLANT SURFACE OR FROM A LIQUID FILM ON A POROUS PLATE.

STEP II: A HIGH FLUX PULSE IGNITES A LASER SUSTAINED DETONATION WAVE AT THE SURFACE. A FRONT OF HIGHLY ABSORBING PLASMA, WHICH SHIELDS THE SURFACE FROM FURTHER LASER RADIATION, PROPAGATES BACK TOWARDS THE LASER, HEATING THE GAS PROPELLANT TO ≈ 20,000 °K. THE BEAM IS TURNED OFF WHEN THE FRONT HAS PASSED THROUGH MOST OF THE GAS. THE CYCLE IS REPEATED AFTER THE HOT GASES HAVE EXPANDED.

Figure 4

The laser sustained detonation wave rocket engine[2] is one of several approaches[4,5,6] to achieving the specific impulses necessary for single stage ascent to geosynchronous orbit. Since it is a pulsed device, atmospheric bleaching can be achieved to give good transmission at the 10.6μ wavelength. The first pulse determines the amount of propellant to be heated and the second pulse does the heating. This allows control of the specific impulse, which scales as (flux/density).

Typical operating conditions for an 800 s.I_{sp} engine would involve evaporating propellant to give an average density of 1/3 normal atmospheric over a distance of approximately 7cm from the base. A 2 x 10^7 watt/cm^2 thrust pulse; of 10 us duration heats the propellant and puts an impulsive load of approximately 30 atm on the base. The subsequent expansion is confined by a skirt of approximately 70 cm length. The calculated internal efficiency is 44%. Internal efficiency is defined as the ratio of one half the gas mass times the square of the effective exhaust velocity divided by the incident energy.

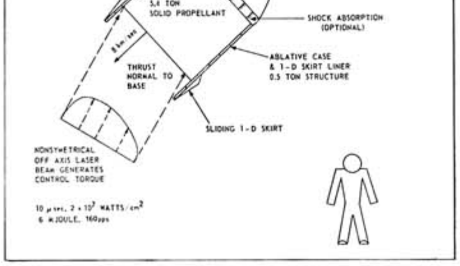


Figure 5

This figure presents a conceptual vehicle design for a single stage to geosynchronous orbit rocket using solid propellant. Reinforced ice is a possible propellant candidate. The flux distribution of the thrust pulse and the propellant metering pulse is controlled by optical feedback to the laser from sensors on the vehicle (not shown). Control torques are generated by using nonsymmetrical flux distribution. The thrust generated by the detonation wave is normal to the base of the rocket, and this allows the laser beam to be somewhat off axis to the vehicle. Payloads such as coils of metal to be fabricated into large space trusses would not need cushioning against the impulsive accelerations. For more sensitive loads, peak acceleration could be kept less than 150% times average accelerations using maximum spring (or gas bellows) travel of less than 10 cm.

ignored laser propulsion as a means of ground-to-orbit transportation (it would compete with the shuttle, after all!), they have supported study of it for orbit-to-orbit flight. The Department of Defense, being less wedded to the shuttle, is supporting ground-to-orbit work. Why they are interested in a system with the capability of launching many thousands of tons per year is open to speculation.

Compared to large space freighters, laser propulsion offers several potential benefits to space industry, including lower development cost, lower operating cost, and lower environmental impact. Of these, the first two are uncertain and the last is of uncertain value; however, if release of water in the stratosphere should someday prove to limit rocket traffic, laser propulsion can either permit a larger payload per unit of water released, or can sidestep the issue entirely by using argon (an inert gas making up roughly 1% of the atmosphere) instead.

On the political side, other nations might view such a laser facility as a threat. In addition to giving the U.S. an impressive launch capability (Russia would doubtless prefer we had none), a 1 GW beam capable of being focused 1000 kilometers up would make a fine anti-satellite weapon. Making the facility part of an international spaceport could resolve this problem, and could help make better use of its enormous launch capability at an early date.

For space mines and space colonies, laser propulsion is a mixed blessing. On one hand, cheap transportation from Earth decreases the motivation for establishing space mines and space manufacturing facilities, and hence undermines the rationale for the O'Neill scenario. On the other hand, cheap space transportation will cut the cost of all operations in space, including space mines and space manufacturing. To the best of my knowledge, no one has given detailed consideration to how lowered launch costs affect the value of space manufacturing, but one thing seems certain: laser propulsion can at worst delay the utilization of non-terrestrial materials, while making their eventual use more certain, more economical, and more accessible to people as a whole.

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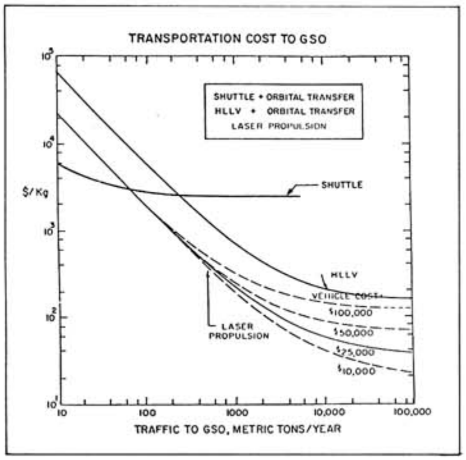


Figure 6

Due to the large capital costs of the lasers and the captive electrical generating facility, the full economic benefits of laser propulsion are only realized at large traffic levels. The 10^5 ton/year launch capability is sufficient to emplace a number of 5 G watt satellite solar power stations per year. Thus the energy payback time on the 4 G watt average launch power is short.

Even at a low traffic level of 100 tons/year, the laser propulsion system is competitive with the shuttle. Actually two systems are complementary since the shuttle can carry those loads which could not possibly be broken down into one ton masses.

The shuttle costs are based on payload optimization[7]. The cost at low traffic levels shows the effect of Orbital Transfer Vehicle[8] amortization. At very high traffic levels, economies of production would undoubtedly reduce the shuttle costs. The HLLV cost projections are also from Ref. 8.

BIBLIOGRAPHY UPDATE

by Conrad Schneiker

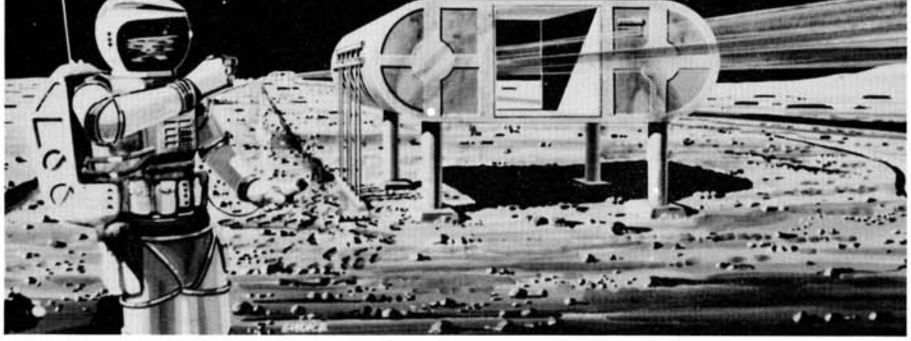
"Mining The Moon And Asteroids And Living in Space"
Brian O'Leary
Astronautics & Aeronautics, March 1978
Commentary on striking color paintings illustrating key facets of space manufacturing studied at the 1977 NASA-Ames Summer Study.

"The Low (Profile) Road to Space Manufacturing"
Gerard K. O'Neill
Astronautics & Aeronautics, March 1978
The article we (at **L-5 NEWS**) have all been waiting for. It describes an exciting new possibility for speeding up space industrialization. This involves powdering the Shuttle's external tank for solar-powered mass-driver propellant, yielding a 'breakthrough in space transportation economics." This and other developments cited greatly reduce the "ignition point" time (where dollar income exceeds dollar investment). A wealth of technical data is presented to bring the reader up to date on the latest developments in the High Frontier concept.

"High Frontier—Technical Progress, A Resolution, Commitments"
Gerard K. O'Neill
Astronautics & Aeronautics, March 1978
Introduces a special section in this magazine devoted to the High Frontier concept. The substantial advances made in this concept in 1977 are listed. The problems of promoting this concept as a program and the uncertainties facing it are mentioned. In reply to the oft'ed asked question of whether he will be swayed from his research if the Executive Branch attempts to stamp out research into the High Frontier, O'Neill gives a solid "NO."

IEEE Book Review of
The Zapping of America
P. Brodeur
D.R Justesen Charles Susskind
IEEE Spectrum, May 1978

This excellent review of the book on "deadly" microwaves and the microwave "cover-up" fills large gaps of relevent information ommitted by the book's author. The book's plausibility plummets as the reviewers present case after case of such gaps. Here are some examples. In reviewing the Moscow embassy microwave incident the author ignores the possibility that "revelent" Soviet "findings" are about as genuine as the recent Soviet "expose" of OTRAG's activities — i.e. scare tactics and propaganda. Other possibilities exist: microwaves bouncing off microwave-reflective surfaces subject to sound-induced vibrations may be used to listen in on conversations from a long distance, the U.S. may be using the alleged low-level microwave



An illustration from "Mining the Moon and Asteroids and Living in Space."

danger as a propaganda tool of its own, etc. In consideration of various population groups alleged to be suffering from microwave-induced ailments, the author ignores relevant group characteristics already known to account for increased incidence of such ailments in the groups mentioned (e.g. advanced age, high stress levels, etc.) One case cited as evidence of microwave-caused problems was just that: one case. It was subsequently contradicted by dozens of published experimental studies. In citing an experiment involving white-cell changes in mice, the author omits a crucial fact: the mice irradiated (by "deadly" microwaves) lived LONGER than the control group! And so it goes . . . Of course there can be dangerous levels of microwave radiation, and of course microwave related hazards require serious study, and of course the public should be well informed on the subject. In that light this sensationalistic book is a failure.

Future
April 1978
This new magazine bills itself as "the magazine of science adventure." It seems to be oriented toward the "reality fringe" of the science fiction crowd. It is packed with interesting, very well illustrated (in color) articles. They include Isaac Asimov on "Society in the Future," Jesco von Puttkamer of NASA on "Searching for Life on Mars," interviews with Fred Pohl (SF author) and Doug Trumbell (special effects wizard for 2001, Silent Running, and Close Encounters), a fiction piece set in what looks like an O'Neill Model IV space colony, and much more. And what's this here? It even has a review of the **L-5 News.** For subscription info, write **Future** Magazine, Inc., 475 Park Ave. South, 8th Floor suite, New York, NY 10016.

Space Age Review
January-February 1978
This issue marks an impressive improvement in print quality, layout and content over the previous issue. In addition to articles, there is a fascinating 10 page chronology of major space events of July through December 1977. One of the neat goodies is mention of Robert Truax ("father of the polaris missile") and his scheme to beat NASA at making the first piloted shuttle flight with his own hardware. Price: a mere half million dollars. For subscription info, write **Space Age Review**, 378 Cambridge Ave., Palo Alto, California 94306.

Skylark, Smithy In Space
Dagmar Heller
New Scientist, December 1, 1977
"The West Germans are buying British sounding rockets to learn how to fabricate pure materials under zero-g conditions. Their eyes are fixed firmly on future commercial applications." Some experiments to use the six minute free fall provided by the Skylark rocket are described. This free fall lowers forces on the payload to about 1/10,000 g.

Extraterrestrial Resources In The Solar System
Calvin Alexander
Foundation Report, January 1, 1978
"Materials shortages? Never Again." The materials are there for the taking in the form of asteroids. "To get at this material, there is no requirement for underground or pit mining, no waste disposal problems, no need to pay outrageous prices for energy in the form of process heat." We only need economical space flight.

Space Factories In 1997 -- Part 2
Dave Dooling
Spaceflight, November 1977
Considers difficulties in getting industry involved in space industrialization. Two promising products for space processing are discussed. They are urikinase (for prevention of blood clots) and silicon ribbon (for use in the microelectronics industry). For these items, it appears that space processing offers large advantages over current ground-based processing.

Militarization And The Outer Space Treaty—Time For A Restatement Of Space Law
George M. Robinson
Astronautics & Aeronautics, February 1978
A call to put teeth and resolve into the Outer Space Treaty of 1967 in order to limit the militarization of space.

Freedom Of Passage On The High Seas Of Space, Lt. Col. Richard E. Hanson, USAF-Ret., **Astronautics & Aeronautics,** February 1978
Presents a rationale for uniformed aerospace forces to assure freedom of passage in space, among other things. In effect, this is a call for increased militarization of space.

New Works In Space
James E. Kingsbury
Astronautics & Aeronautics,
January 1978
Examines a variety of near-term space programs, both planned and under serious consideration. These include use of large space structures for communications, materials processing, and astronomy.

Economic & Environmental Costs Of Satellite Solar Power
Peter Glaser
Mechanical Engineering, January 1978
Briefly examines economic viability, socio-economic impact, and environmental effects of satellite solar power systems.

News Roundup/The Permanent Occupation of Space
Shana Goldberger
Mechanical Engineering, January 1978
A good overview of the 1977 AAS Industrialization of Space conference. Concentrates on the hardware aspects of space manufacturing.

Bargain Basement Rocket
John Dornberg
Popular Science, March 1978
By far the best article on OTRAG's innovative and common sense commercial approach to rocket launcher construction to appear in print. Details design philosophy, hardware, launch projections, marketing plans and history of this venture. Highly recommended.

"New Developments in Electromagnetic Energy Beaming"
Ervin J. Nalos
Proceedings Of The IEEE, March 1978
This issue summarizes electromagnetic energy beaming trends. Of interest to L5-ers are parts concerned with the microwave frequency spectrum, large-aperture antennas, high power-long distance beaming and radio frequency to direct current conversion. These developments and their impact on the SPS are considered and illustrated via the front cover artwork.

The Disposal of Nuclear Wastes in Space
Michael A. McCallum
Analog, March 1978
Considers nuclear power station economics and safety aspects of nuclear waste disposal. A convincing argument is made for not only the feasibility of nuclear waste disposal in space but for the safety and economy of such a program as well. Extra bonuses include keeping the Shuttle busy and elimination of high-level wastes generated by the U.S. nuclear weapons program.

Air & Space
March 1978
This is the new mini-magazine from the National Air & Space Museum (Smithsonian Institution). It's for (and free to) educators. Twelve pages of professionally done, well illustrated, shorts, non-technical articles on the U.S. space program and related topics appear in this issue.

Space World, April 1978
Without minimizing the enormous difficulties inherent in interstellar flight, methods for achieving it without exotic new technologies are presented. One particularly simple scheme involves a large solar sail — powered by a battery of lasers in solar orbit — and the laser beam's energy flux needn't be especially high.

NORAD Provides A Long Range Look Into Outer Space
"NORAD News Release"
Space World, April 1978
Mentions situations where NORAD's Cheyenne Mountain Intelligence Center has assisted NASA. NORAD can determine whether or not a panel on a satellite is correctly deployed even though the space object is 1,000 miles or more from the radar tracking site.

"Volksraketen For The Third World"
Farooq Hussain
New Scientist, March 23, 1978
Yet another article on OTRAG. Notes the close conformance of the "OTRAG" Penthouse article to East German and Soviet inspired propaganda on the subject. Also mentions a number of glaring errors in that article. Gives a very brief history of OTRAG and some of its technical innovations.
National Scene: "Ariane vs. Space Shuttle"
Wilbur L. Pritchard
Astronautics & Aeronautics, April 1978
"The developing competition between NASA's Space Transportation Systems . . . and the European Space Agency's launch vehicle Ariane presents us with the most fascinating contest in the space business since the U.S. and USSR raced for the Moon of the Sixties." The advantages and drawbacks of the Shuttle vs. Ariane are compared. Neither system emerges as the clear cut winner. The potential user community is so diverse it seems no single system could ever be adequate. In the Shuttle-Ariane drama, politics may be the deciding factor. For example, the U.S. will no longer be able to block competition with the intelsat satellite system.

"Space Transportation — New Heading For The Future"
Robert Salkeld, Donald W. Patterson
Astronautics & Aeronautics, April 1978
Summarizes a forthcoming survey of the new space transportation system and technologies leading to more economical follow-ons.

"Solar Sails"
Steve Lee
The Cornell Engineer, December 1977
Explains the design (square and heliogyro), use (maneuvering), and benefits (no fuel consumed) of solar sailing. "The technology is at hand, the potential is immense; only the funds and the drive to go ahead are missing."

"Cornell Engineer Interview: Dr. Gerald K. O'Neill"
Corey A. Burchman
The Cornell Engineer, December 1977
The interview ranges over many topics including the history and present status of the high frontier concept, the mass-driver, extra-terrestrial life in our galaxy, and the end of the dead-end limits-to-growth world view.

"Into Space By Low Technology?"
Kenneth W. Gatland
Spaceflight, January 1978
An article on OTRAG's hardware, supplemented with a good deal of criticism. The critical remarks are of a technical and economic nature as opposed to the usual silly propaganda. Despite the article's very negative tone, the author concludes: "Whatever the outcome may be one cannot but admire the company's determination to prove a case for low-cost technology in a very difficult field of technical endeavor.

"Satellite Power System LEO vs. GEO Assembly Issues"
John Mockovciak Jr., Rudolph J. Adornato
AIAA Journal Of Energy, January-February 1978
Based on considerations of structural loading, attitude control, and collision probability for a strawman SPS, complete assembly in LEO followed by transport to GEO does not appear technically desirable. The best mix of LEO vs. GEO construction activity remains an open question.

"The Secret U.S.-Soviet Satellite War That Can Destroy The World"
Ernie Volkman
Argosy, April 1978
Despite the sensationalistic title, most of the text concerns spy satellites and their capabilities. There is some discussion of killer satellites, most of it speculative in nature. A few interesting events in this "war" are presented. For example, a spy satellite made use of the discovery that Russian nuclear submarines left a trail of (presumably radioactive) iodine allowing easy detection and tracking of these subs from space.

"Space for Women"
Space World, March 1978
This article was derived from a symposium concentrating on ". . . the realities of careers for young women." Includes a good discussion of the important topic of career-building.

"OTRAG: This Space For Sale"
James Oberg
Future, July 1978
A brief summary of the OTRAG adventure, which is ". . . as bizarre as any science-fiction scenario could hope to be."

"On Humanity's Role In Space"
Jesco Von Puttkamer
Spaceflight, February 1978
Considers societal, political, economic, psychological and operational aspects of roles humanity can play in space utilization. ". . . in anticipating the future it is important to emphasize that any limits that people can now set are most likely naive."

"The Air Scooping Nuclear-Electric Propulsion Concept For Advanced Orbital Space Transportation Mission."
R.H. Reichel
Journal Of The British Interplanetary Society, February 1978
An economic analysis of an LO_2/LN_2 collection system operating in a very low 109km orbit shows great cost savings for delivery of propellents to high earth orbits.

'Space: Industry's New Frontier"
Vernon Louviere
Nation's Business, February 1978
A long article describing the Space Shuttle program and the new era of space industrialization it may give rise to. Many new business opportunities and large projects likely to exist at that time are discussed.

SOLAR REVIEW AVAILABLE

"Solar Energy Research and Development: Program Balance," DOE/IR-0004, February, 1978, is available at the National Technical Information Service (NTIS) for $4.50. This DOE report was a review by the General Advisory Committee of the Energy Research and Development Administration (ERDA), which became the Solar Working Group when ERDA was incorporated into DOE last October. Copies may be ordered from NTIS at 5285 Port Royal Road, Springfield, Virginia 22161.

Two documents done for the Solar Working Group by SRI International entitled: "Solar Energy Research and Development: Program Balance," Annex, Volume I, HCP/M2693-01 and Volume II, HCP/M2693-02, provide more detail. These two volumes are expected to be available from NTIS in the near future.

A new guide to DOE's solar energy programs contains information on program activities and structure, procurement methods and sources of solar energy information. Written in non-technical language, the guide describes technologies being emphasized in the various programs of the Division of Solar Technology: thermal power, photovoltaics, fuels from biomass, ocean thermal energy conversion, wind and satellite power systems. It also covers the following programs under the Assistant Secretary for Conservation and Solar Applications: heating and cooling applications, agricultural and industrial process heat and technology transfer.

Guide to Solar Energy Programs, DOE publication ET-0036, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (ask for Stock No. 061-000-00042-9). Price: $2.40.

Market Announcement: For 1979 Publication Anthology: Working Title "The High Frontier"

Theme anthology of stories involving permanent colonies not on planets: "O'Neill Colonies", other artificial environments for permanent habitation, including asteroid civilizations but with major stress on artificial nature of environment (which presumably becomes "natural" to the inhabitants).

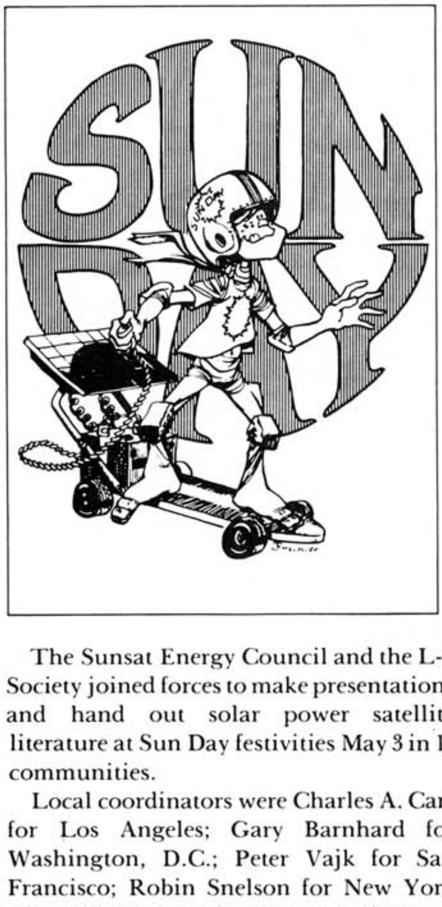
Nominal advance against pro-rata share of 50% of all royalties received by author. Book will be represented by Lurton Blassingame Agency and agent fees will be deducted. The book will be marketed abroad, some overseas sales already assured, pro rata royalties will be paid on all foreign sales. US publisher is ACE Books.

Rights bought: non-exclusive world anthology rights only.

As in my past anthologies, authors are invited to write stories for this collection and market the serial rights for publication prior to publication of the collection. Higher advances will be paid for original stories, but **pro-rata** shares will not be different. Sufficient time will be allowed for serial publication.

Previously serialized or anthologized stories also welcome.

Stories should use the non-planetary habitation as an integral part of the story, although a sufficiently good story in which the habitation is merely incidental will be considered. Send with ms. SASE and business-size SASE for editorial reply to Jerry Pournelle, 12051 Laurel Terrace Drive, Studio City, California, 91604.



The Sunsat Energy Council and the L-5 Society joined forces to make presentations and hand out solar power satellite literature at Sun Day festivities May 3 in 17 communities.

Local coordinators were Charles A. Carr for Los Angeles; Gary Barnhard for Washington, D.C.; Peter Vajk for San Francisco; Robin Snelson for New York City; Bill Wheaton for Boston; Julia Tracy for Seattle; Chuck Lundgren for Sacramento; Peter Mikes for Dallas; Michael Shields for San Diego; Lawrence Boyle and Jim Seevers for Chicago; Debby Byrd for Austin; Ken McCormick for Philadelphia; Riley Bishop for Kansas City; Bill Gardiner for Atlanta; Jon Roland for San Antonio; and Tim Katterman for Raleigh, NC. Rice University in Houston, Texas put on a display which included a working model of an SPS, complete with microwave transmission.

In some communities, most notably Philadelphia, solar power satellite proponents were met with active hostility by local Sun Day organizers. The reason given for their SPS antipathy was opposition to centralized and "high technology" power sources—of any nature.

However, in most communities the solar power satellite proponents were accepted as part of the "legitimate" solar energy community. Our thanks to all of you who worked together on the Sun Day project!

For more information about Sunsat, write or call:

Sunsat Energy Council
600 New Hampshire Ave. NW
Suite 480
Washington, DC 20037
202/338-8874

"SUN DAY" RESOLUTION

"May 3, 1978, is going to be Sun Day, a day of celebration for solar energy. If the public's reaction to it is anywhere near as enthusiastic as the Congress, Sun Day will be a very popular event indeed . . . . Sun Day is not anti-anything. It is simply and solely prosolar energy. For one day energy problems will take a back seat to an energy solution. While no single solar technology is going to solve our energy problems, the combination of all solar technologies can handle many of our needs. And Sun Day can make people aware of the scope and potential of solar energy." —*Sen. Charles Percy before the Senate in support of the joint resolution (H.J. Res. 715) proclaiming May 3, 1978, "Sun Day" which was passed.*

Zuni Chant Fails Ottinger

In one of Sun Day's first ceremonies, Rep. Richard Ottinger (well known to L-5 readers for his anti-SPS activism) and James Jeffords led 1,500 solar power devotees to the peak of Cadillac Mountain in Maine to greet the rising sun. Unfortunately, the weather was uncooperative, with clouds blocking the view. The crowd tried a sunrise call used by the Zuni Indians, to no avail.

Unfazed, Ottinger announced "We're here to celebrate the dawning of the solar age and bring the Administration kicking and screaming into it."

We recommend that Ottinger try his Zuni chant in geosynchronous orbit next time. We can *guarantee* the results.—*CH*

Even if the organizers of the Sun Day are opposed or even hostile to anything which may "smell of high technology" such as SPS, we at L-5 should restrain ourselves from any activity which may be interpreted as a negative attitude toward SP terrestrial (SPT).

Last thing we want is to create in the public mind an image of SPS and SPT as two opposed or competing concepts. SPT may have been over sold, but it is nonetheless needed and it is in line with public sentiment.

Peter Mikes
Dallas, Texas

The L-5 Space Futures Society table during Sun Day festivities in Philadelphia.

Ken McCormick delivers introductory lecture on SPS for Sun Day activities in Philadelphia.

I would like to remind you of the fact that, although I did my best to coordinate the efforts of the Space Futures Society with those of the Sunsat Energy Council and the local chaper of the AIAA, I was by no means *the* local coordinator for Sun Day, as was reported in the LIS newsletter. I was just one of the several members of the Space Futures Society who worked hard to put on a presentation in Philadelphia which drew more of a crowd than the rest of the solar energy groups combined.

I think the mention of active L-5'ers in your newsletter is an important morale booster for those mentioned, but to single out one person for mention in an area where many are active can be an inadvertent slight to those not mentioned. If anyone should receive credit for our very successful presentation here, it is Rich Bowers, without who, since he organized the local group, there probably would not have been any presentation at all. Rich also made arrangements for our lecture hall and information booth, and was really the driving force behind all our Sun Day activities. Our slide show was prepared by Jon Alexander, with assistance from myself, Eric Laursen, Ron Smolin, Marc Hess, and Paul Hess.

I delivered a short speech before the slide show, which was presented by Jon Alexander; Ron Smolin then spoke about our organization, and Eric Laursen and I fielded questions. Ron Smolin and I both sent out press releases for Space Futures, Sunsat, and AIAA. Ron designed and printed our advertising posters; all active members of our group distributed the posters. The L5/Sunsat information booth was manned in turn by Ron Smolin, myself, Paul Hess, Marc Hess, and Rich Bowers.

Because the above mentioned people worked just as hard or harder than I did to bring about our presentation, and because other members of our group have put on local presentations at other times, it was somewhat of an embarrassment for me to be singled out for mention by LIS. I would be most grateful if you would, if it is at all possible, rectify the situation.

Jon Alexander and I joined Bruce Bon and Ray Hoover of the Maryland Alliance to distribute L5 Society literature and space colonization books at a recent science fiction convention in Washington D.C.. As at the New York convention which Jon Alexander and I also attended, the blue, one inch L5 buttons sold very well.

Thank you for your kind mention in the LIS newsletter of the National Action Committee for Space. We are not attempting to recruit members of the L-5 Society into the National Action Committee because they already have a very fine legislative information service--your own. You have done an outstanding job so far, and it has never been our intention to compete with you. I fear that we would look somewhat the worse in comparision, anyway.

The main purpose of the National Action Committee at this time is to provide for people who are not L5 Society members a legislative information service such as we both began to advertise last November. We feel that there are many members of other organizations who are eager to take action to support an enlarged space program, but who, for one reason or another, have not yet joined the L5 Society.

Ken McCormick
Birchrunville, PA

Inside the... L-5 Society

Call for Papers

The American Astronautical Society's 25th Anniversary Conference, "The Future United States Space Program" will be held October 30 through November 2 in Houston, Texas.

The L-5 Society, a co-sponsor of the conference, is organizing a session for the afternoon of October 30 titled "Social Aspects of Space". Topics which fall under this heading include (but are not limited to) internal social and political structures that might be found in space settlements; social/political/environmental effects of large scale space industries, power satellites and space settlements on the Earth; possibilities for private space enterprises and their impact; and the political problems of funding space projects.

We hope that this session will inspire some controversy. If you have an interest in giving a paper which contradicts what you feel is the space colony "party line", by all means send us an abstract! Papers which bring up historical parallels, discuss treaties and bills under consideration, explore recent research findings, or propose innovative concepts are desired—generalized tomes on the virtues of capitalism, heterogeneity, feminism, "ecology", etc. are not desired.

Please mail your abstracts to the L-5 Society, 1620 N. Park, Tucson, AZ 85719 before August 30. The session will be chaired by Carolyn Henson; co-chairman is Don Hervey.

Boston L-5

"Why it is urgent that we look out into space at the present time, is that the prophets of doom may be right."

The Boston Chapter of the L-5 Society celebrated its founding at a May 17 wine and cheese social. The celebration was sponsored by SPACE, a Boston-based educational organization concerned with increasing public awareness of the potentials of space industrialization. Among the forty-plus people in attendance were former astronaut, Phil Chapman; Arthur Kantrowitz, Director of Research at Avco-Everett Labs; Eric Drexler, Kevin Fine, Marc Hopkins and Bill Wheaton.

Wayne Jefferson, founder of SPACE, opened the evening by announcing that efforts were underway to proclaim July 20 as Massachusetts Space Awareness Day. Governor Michael Dukakis has been approached and is expected to make the proclamation some time in June. SPACE has had notable success with its past projects. In recent months its members have appeared on radio and television programs and have lectured before audiences throughout Massachusetts. A non-profit group, SPACE will be incorporated during the summer months.

Bob Nichols, who organized the L-5 chapter, outlined some of the projects the chapter will undertake. Nichols sees the chapter as being oriented toward television and radio talk shows. Nichols added that he had been in contact with the Boston PBS affiliate, WGBH, which expressed interest in televising a debate next season on space colonization. The chapter will be instrumental in organizing the debate.

After Nichols' talk the meeting turned to technical presentations by Kevin Fine and Eric Drexler. Fine gave a short overview and history of mass driver projects. He also discussed the newest mass driver now being constructed at Princeton by Gerard O'Neill. Eric Drexler gave a talk on the use of thin metal film solar sails for interplanetary transportation. Drexler believes that such sails may prove to be the most economical means of traveling in the inner solar system.

Dr. Phil Chapman delivered the keynote speech. He observed, "Our sun puts out enough energy to provide (an adequate standard of living) for something like ten million times the present world population. In order to utilize large amounts of energy, as well as to generate large amounts of energy, we have no option but to go out into space.

"One of the reasons, then, for pursuing a massive invasion of space by the human race is that it does free us from these various limits which people are telling us are going to mean that we have to lower our sights and live in a much more Spartan style in the future than we do now.

"Why it is urgent that we look out into space at the present time, is that the prophets of doom may be right. If we postpone establishing beachheads and colonies out in space, then we're going to find that there are other pressing needs that are going to come upon us. We're moving rapidly towards a situation in which the underdeveloped countries are going to demand their piece of the cake. And if we wait until we share out the cake . . . if the goods of the world, the present gross world product, is distributed evenly across the world, then you would find that there is very little surplus. Indeed, to feed adequately all the people we're going to have in the world in the year 2000 would require 70% of the present world energy production.

"We need to use the surplus in the interim, before that gets changed, to establish a beachhead in space so that we can go on expanding, so that we can go on living in an environment in which the pie is getting bigger and bigger instead of being preoccupied with dividing the pie up into smaller and smaller slices.

"There is one final reason, and perhaps the most overpowering reason, why I think it's essential that we press on rapidly with getting into space and that has to do with the nature of the human spirit, the nature of what man is, of what makes life worth living, of what makes man different from animals.

"I feel that this is best expressed in a poem, of which I am very fond, that Wade asked me to read to you this evening, and that is Tennyson's "Ulysses".

It little profits that an idle king,
By this still hearth, among these barren crags,
Match'd with an aged wife, I mete and dole
Unequal laws unto a savage race,
That hoard, and sleep, and feed, and know not me.
I cannot rest from travel; I will drink
Life to the lees. All times I have enjoy'd
Greatly, have suffer'd greatly, both with those
That loved me, and alone; on shore, and when
Thro' scudding drifts the rainy Hyades
Vext the dim sea. I am become a name;
For always roaming with a hungry heart
Much have I seen and known,—cities of men
And manners, climates, councils, governments,
Myself not least, but honor'd of them all,—
And drunk delight of battle with my peers,
Far on the ringing plains of windy Troy.
I am a part of all that I have met;
Yet all experience is an arch wherethro'
Gleams that untravell'd world whose margin fades
For ever and for ever when I move.
How dull it is to pause, to make an end,
To rust unburnish'd, not to shine in use!
As tho' to breathe were life! Life piled on life
Were all too little, and of one to me
Little remains; but every hour is saved
From that eternal silence, something more,
A bringer of new things; and vile it were
For some three suns to store and hoard myself,
And this gray spirit yearning in desire
To follow knowledge like a sinking star,
Beyond the utmost bound of human thought.

This is my son, mine own Telemachus,
To whom I leave the sceptre and the isle,—
Well-loved of me, discerning to fulfil
This labor, by slow prudence to make mild
A rugged people, and thro' soft degrees
Subdue them to the useful and the good.
Most blameless is he, centred in the sphere
Of common duties, decent not to fail
In offices of tenderness, and pay
Meet adoration to my household gods,
When I am gone. He works his work, I mine.

There lies the port; the vessel puffs her sail;
There gloom the dark, broad seas. My mariners,
Souls that have toil'd, and wrought, and thought with me,—
That ever with a frolic welcome took
The thunder and the sunshine, and opposed
Free hearts, free foreheads,—you and I are old;
Old age hath yet his honor and his toil.
Death closes all; but something ere the end,
Some work of noble note, may yet be done,
Not unbecoming men that strove with Gods.
The lights begin to twinkle from the rocks;
The long day wanes; the slow moon climbs; the deep
Moans round with many voices. Come, my friends,
'Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die.
It may be that the gulfs will wash us down;
It may be we shall touch the Happy Isles,
And see the great Achilles, whom we knew.
Tho' much is taken much abides; and tho'
We are not now that strength which in old days
Moved earth and heaven, that which we are, we are,—
One equal temper of heroic hearts,
Made weak by time and fate, but strong in will
To strive, to seek, to find, and not to yield.

"I think the spirit of Tennyson's "Ulysses" is one which has been downgraded in this society in the last few years. The spirit of Telemachus which says let us do the immediate things that need to be done, that we have to worry about—'what do we do about sewerage disposal'?—is the spirit which has today become dominant in our society. I for one am thankful that the spirit of Ulysses is still alive and well and living in Tucson."

Phil brought his talk to a close with a toast to the new L-5 Chapter and SPACE: "I would like to offer a toast to the proposition that this next generation has got to get up and out so that the next generation won't find itself down and out."

Phil's toast was received with a warm and loud chorus of here-here, bravo, and general joyous cheers.

Eric Drexler brought the evening's ceremony to a close saying: "This concept has gone a long, long way from 1970 when I started working on it. There was a time when no one was interested in this and, from that perspective, I think that we're half-way there."

After the formal presentations, the social continued on into the night with a dozen people discussing projects and arguing over strategies for the future until after dawn.

Anyone in the new England region who is interested in becoming involved in the L-5 Chapter please contact Bob Nichols at 110 Ewing Drive, Stoughton, Mass., 02072. Tel. 617/344-9570

Governor Proclaims Space Awareness Day

On June 26 governor Michael Dukakis of Massachusetts proclaimed July 20th as Massachusetts Space Awareness Day. This commemoration of the first Moon landing was initiated by the Boston-based organization, S.P.A.C.E., to provide a focus for promoting awareness of the New Space Program through the local media and specially organized activities. Similar efforts by other organizations around the country could turn July 20, 1979—tenth anniversery of the Apollo 11 landing—into a significant national event.

New L-5 Chapters

Tulsa L-5
President: Tom Huffman
3424 E. 41st
Tulsa, OK 74135
Secretary/Archivist: Andrew Westphal
Treasurer: Gary McClure

University of Houston L-5
c/o Physics Department
University of Houston
Houston, TX 77004

North Carolina State L-5
Robert Baldwin, Coordinator
Rt. 4 Box 121A
Waxhaw, NC 28173

State-Wide Organization Planned

Five local chapters of the L-5 Society in Texas are proud to announce our intent to form a state-wide organization. We plan to hold a charter convention on 26 August in Austin, and invite all interested Texans to attend. For more information, contact R.J. Howe, interim chairman, at (512) 472-8930, or write 306 East 30th, No. 108, Austin TX, 78705.

BAY AREA L-5

The Bay Area Chapter of the L-5 Society has been launched by an enthusiastic group meeting in Berkeley, California. The Chapter President is Mike Davis and the Secretary-Treasurer is David Brandt-Erichsen. The Chapter address is 814 Miramar Avenue, Berkeley, CA 94707. Anyone interested in participating please write or call David at (415) 526-9346 (home) or 645-5990 (work) or Mike at 845-2285 (evenings).

We are looking for (1) a free meeting place where we can hold regular monthly meetings, show films, give public lectures, and which can hold 50 or 60 people; and (2) free use of a 16 mm movie projector. If you know of either, please let us know right away.

The primary purposes of our chapter are to educate the public reguarding the possibility and desirability of space colonization, and to educate ourselves so we can better accomplish this. Our first major goal is to start a chapter at the University of California in Berkeley and to open the Fall quarter with a large publicity campaign. We intend to spend the summer gearing up for this.

We are preparing a slide show which we will make available to anyone in the area.

If any of you would like to participate with us, please let us know.

LA L-5

OASIS (Organization for the Advancement of Space Industries and Settlements, the Los Angeles L-5 chapter) will be holding regular meetings on the fourth Sunday of every month at 7 P.M. The July 23 meeting will be held at the Kiwanis Youth Center, 2525 Valley Dr. in Hermosa Beach. For more information or directions call Terry Savage, 374-1381 or 536-3209.

Status Report - John Muir High School

Howard Gluckman and John Sigwing of Space Science Media Group recently attended a meeting to demonstrate the equipment they use in their multi-media presentations on space colonies. The school has agreed to pay for the two to bring their presentation to Muir in early June when it is completed. The presentation is designed to be entertaining as well as educational, which should make it very suitable for high school students.

Several members are currently working on a questionaire to be distributed to L-5 members and the general student body. The questionaire would be designed to determine who would be best physically and psychologically suited to travel in the space shuttle and live in a space colony. The winner would be given an award, such as a model of the space shuttle, or something similarly appropriate and inexpensive. The main purpose of the project is to let students know how easy it is really to fly in the shuttle and to supply some needed L-5 publicity.

On other fronts, we hope to have a candy sale to help our rather pitiful account. We have obtained a relatively large selection of films to show at our meetings from NASA Ames Research Center, and hope to have several lecturers, including a J.P.L. employee scheduled to fly in the shuttle. We continue to pass out as much L-5 literature and other materials as we possibly can to as many people as possible.

Canadian Lecturer

Peter Jedicke, of London, Ontario, has given a talk on Space Colonies at a number of meetings, including the Royal Astronomical Society of Canada in Toronto, Hamilton, Niagara Falls, and London, and Viking, Alberta on May 22. Peter would be happy to give his talk anywhere in Southwestern Ontario, and he can be contacted at 519-433-2992.

FINANCIAL NOTE

Last month's "Revenue and Expense Statement, July 1, 1977 — April 30, 1978" showed a net operating surplus of $3,363.28. This is *not* money in the bank, itching to be spent: it is merely an increase in the quantity "assets minus debts."

BALANCE SHEET
May 1, 1978

ASSETS	
Bank	$(157.91)
Office Equipment	9,252.00
TOTAL ASSETS:	$ 9,094.09
LIABILITIES:	
Current Loans Payable	$ 420.33
Payroll Taxes Accrued	26.45
Note Payable, Office Equipment	7,864.20
TOTAL LIABILITIES	$ 8,310.98
CAPITAL ACCOUNT	$ (2,580.17)
Plus Surplus to Date	3,363.28
NET WORTH:	$ 783.11
TOTAL LIABILITIES AND CAPITAL:	$ 9,094.09

Translators Needed

Phil Parker would like members to contact him if they are able to perform a small amount of translation from English to French and English to German for him. This will enable membership details to be circulated in those languages as well as English.

Letters

"Nothing but Hard Rock"

In O'Neill's article in your March '78 issue I run across a puzzling statement:

> "But no opportunity waits forever, and the chance we now have can be lost within a few years."

I don't understand this at all. What chance is he speaking of, and why can it be lost within a few years? Surely he is not suggesting that if the Russians get into space in a large way before we do, it will be impossible for us to get there. After all, we are told that space is so large and rich that there is room for everyone out there and more. So what difference does it make who gets there first?

There seems some kind of implication that if the Russians get there first they can prevent us from coming out. Is this implication intended? It would follow then, that if we got there first we could prevent them from getting out. Is this the hidden message?

If O'Neill's words do not mean this, what do they mean?

I'm really not asking rhetorical questions here. I would like an answer. On the outside chance that you may not feel inclined to give me one, I am going to pass these questions along to Senator Proxmire and others, who may ask somewhat more insistently, if you know what I mean.

A small point. O'Neill talks about lunar "soil". I understand something about the processes by which soil is generated on the surface of the Earth—the action of wind and rain, of water freezing and thawing, and various biological processes. None of these exist on the Moon. Is O'Neill talking about that lunar dust? I would think quite a lot of something would have to be added to it to make it behave like soil as we know it on the surface of the Earth. How deep is that dust? And what is underneath it? I would guess nothing but hard rock. An exceptionally unpromising environment for any kind of construction.

John Holt
Boston, MA

In reply to Mr. Holt's question, the reference was to an economic rather than a military time-window. It has been pointed out by a number of observers that within one or two decades the economic position of the United States may be even more unfavorable than it is now for the initiation of any major new long-term venture to improve the economy. The approach to zero-population-growth results in a rise in the average age of our population, with a corresponding increasing welfare and social security tax load and a decreasing work force in the prime earning years to pay the necessary taxes. Rising energy costs combine with our losing, year by year, more and more of the share of the worldwide market to industrial newcomers who still retain the sense of vigorous forward motion that we have, to a great extent, lost. Our balance of payments deficit ran 4.5 billion dollars in one month alone this Spring and is projected to rise to $100 billion per year by 1985, with a consequent even more severe inflation and erosion of disposable capital.

Already the weight of these increasing problems has become so overwhelming that successive administrations in Washington spend most of their time coping with day-to-day crises; there is none of the sweeping youthful confidence and vision that spurred the country on to such past ventures as the transcontinental railroad and the Panama canal (both of great economic benefit in their time, whatever their faults). Washington has forgotten that no nation gets rich just by saving money; it must go out and make it as well. The danger is that even if a President with that kind of vision were to appear, if he or she arrives later than one or two decades from now the economic chains of crisis may be so tightly locked that there will be no disposable capital to fund any major new initiative, and that the increasing conservatism of an aging population will not support new ventures in any case. England has already travelled that road, and we are not far behind. Every businessman knows that "you have to spend money to make money," but realization of that fact, based on experience, may come too late if it arrives ten or twenty years from now.

As to the growing of plants in lunar soil, that was already demonstrated some years ago during the Apollo project. As is obvious and as I have detailed in **The High Frontier**, it is necessary to add water and nutrients (i.e. nitrogenous chemicals). The lunar soil is already well supplied with most of the necessary trace elements, because they have not been leached away by centuries of farming and water runoff, as much of our soil has been.

The final sentence is puzzling: ". . . nothing but hard rock. An exceptionally unpromising environment for any kind of construction." The highest buildings in the world, those of New York City, are built on the bedrock of Manhattan Island.

Gerard K. O'Neill
Princeton, NJ

According to an unreliable source, some of those plants grown at JSC were of a variety commonly grown in closets—hence the origin of the "high" frontier.

*On the suitability of rock for a construction base, we quote no less an authority than Jesus: ". . . a wise man who built his house upon the rock . . ." (***Matthew 7:24***). Even in those days, rock foundations were FHA approved.—KH*

Errata

Credit for the artwork on the May and June covers belongs not to Johnson Space Center, but to Denise Watt, of Houston Texas.

In the May issue, the article "Astronaut to Lead Site Visit Group" states that Philip Chapman flew on the Apollo 14 mission in 1970. Apollo 14 did not fly until 1971, and, owing to a shortage of seats, did not carry Dr. Chapman.

In the June issue, the article "Intrinsically Valuable Materials in Space" states that H group chondritic meteorites contain 5 to 9×10^6 grams of platinum per gram of metal. The correct exponent, unfortunately, should have been "-6."

"Wet Diapers Leftism"

In re the **Mother Jones** article quoting Dr. Aden Meinel against L-5 editor Meinel's SPS's, it appears Daddy has let creeping Andy Youngism into the Garden of Aden . . . Suggest the office send someone over to have a word with him, if you know anyone who has any contacts. Parents should be seen and not heard.

One amusing feature of **Mother Jones'** ridiculous clutching about for a Relevant Issue: the main gestalt of the 1960's wet-diapers leftism, of which **Mother Jones** is a warmed over example, was that Daddy really **should** be seen and not heard. Guess that point of view disappears along with one's imagination, spirit, and hairline.

Note that Robert F. Allnutt, formerly one of the big wheels on one of the two major space committees on the Hill, is now director of Legislative Coordination in the Controller's Office, Department of Energy.

David Murphy
Carterville, Ill.

"Dirty T-Shirts"

Really, Carolyn. I thought it was bad enough when you published pictures of L-5 volunteers in dirty T-shirts and Groucho masks, but *this;* this is the pits! How can you expect anyone to take us seriously when you stoop to print a grotesquerie like Paul Siegler's "Be Your Own Astronaut?" It was especially disconcerting to find this ugly blemish in the center of what was an otherwise outstanding issue, with excellent articles by James Oberg, Eric Drexler and yourself.

If Siegler's article were some sort of a gag, I wouldn't mind so much, but he actually seems to be touting Robert Truax's proposal to place Evel Knievel or some other hapless "astronaut" atop a makeshift sounding rocket and blast him or her to the edge of space. As the vehicle would tumble uncontrollably (as Truax admits it would) toward a splashdown hopefully somewhere near Truax's ridiculous recovery "fleet" of one boat and three aircraft, the rocket's "pilot" would doubtless find comfort in the fact that Truax has estimated his or her chances of survival at 90 to 98%.

All of this, of course, would be a travesty of early NASA launches which sent chimpanzees and monkeys aloft for purposes of *research*, rather than public spectacle. Aside from the fact that Truax's "astronaut" would pay one million dollars to participate in this misadventure, there are only two reasons for Truax to place a person in his sounding rocket.

First, the use of any creature but a human being for the passenger in this vehicle would surely invite interference from the S.P.C.A.

Second, the prospect of the fiery death of a mere dumb animal would not draw the crowds of leering spectators which Truax hopes to attract.

Siegler seems to think this "Project Private Enterprise" is a good example of what can be accomplished with our capitalist system. If that were really the case, I would have to regard Soviet efforts to exclude private companies from space as being most commendable.

Ken McCormick
Birchrunville, PA

Those T shirts were clean!—CH

Microwave Debate

In response to the article, "Microwaves: SPS Hazard" (**L-5 News**, May 1978), I would like to challenge the statement on page 6 that nuclear radiation differs from microwave radiation by virtue of coming in particles.

Nuclear radiation includes gamma rays, a form of electromagnetic radiation like microwaves and an exceedingly dangerous form in terms of genetic damage and carcinogenicity because of its penetrability.

Convincing Joe Blow in Arkansas, Los Angeles, and all the other places he lives that microwaves do not share the dangers of nuclear radiation because the former are much lower in energy may be more difficult than by telling him they are qualitatively different, but, if we are to attempt to make our point on the basis of incorrect information or oversimplifications, we can expect our opponents to be very quick to charge that we hide unpleasant facts–or don't know what we are talking about!

Marjorie A. Walz
University, MS

Microwaves and gamma rays are indeed both forms of electromagnetic radiation—but we detect one by the oscillating currents it sets up in an antenna and the other by the sharp clicks it produces in a geiger counter. Physics tells us that everything has both a wave and a particle aspect; the simplification I made is standard, for good physical reasons. Microwave photons have roughly 100,000 times less energy than photons of visible light, and roughly 10,000,000,000 times less energy than gamma ray photons. Thermal agitation of the molecules in your body generates infrared photons with 10,000 times the energy of microwave photons. For this reason, microwave photons are seldom of practical interest unless so many are ganged up that the result may be described as a wave.

A number of book reviews have attacked Paul Brodeur's **The Zapping of America: Microwaves, Their Deadly Risk, and the Cover-up** *as sensationalistic and inaccurate (see Bibliography Update). While this helps our position somewhat, the microwave issue is not about to lie down and go away. As reported on page 7 of the 4 May 1978* **Nature**, *the U.S. Congress General Accounting Office has released a report which concludes that the levels of microwaves to which the public is exposed could be dangerous. Regardless of the physical facts, the political situation will likely worsen. Our best policy is still to argue that SPS can meet the strictest standards yet proposed, and is safe even assuming the worst about the effects of low-level microwave exposure. See "MICROWAVES: SPS HAZARD," May* **L-5 News**.*—E.D.*

"Enemy of Space"

Commenting on Tom Heppenheimer's and Tim Kyger's letters: Proxmire is an enemy of space. The man's mind is closed on the subject, as this quote testifies:

"Although the Carter Administration deserves high marks for rethinking the size of the shuttle orbiter fleet, cutting it from five to four orbiters, NASA's fiscal 1979 budget is still marbled with too much fat. For example, why proceed with the $40 million teleoperator retrieval system now? It is foolish to embark on a $14 million program, the search for extraterrestrial intelligence, with a first year cost of $2 million in a time when we are running a huge budget deficit. New starts such as the solar polar mission and the proposed earth radiation budget satellite may not be essential to the nation's well-being. And, of course, the shuttle itself may turn out to be a multi-billion dollar boondoggle."

I rest my case.

Robert Lovell
Shawnee, KS

Space Program Jobs

I have a job with the Link Division of the Singer Company, as a principal systems engineer. The pay is not as good as it should be, perhaps, but at least I'm working in the aerospace field. As you know, Link is building the Space Shuttle Simulator. I've been working here about six months, and Singer-Link is going through a reorganization and plans to increase the number of employees here from about 270 to around 500. There are some positions available for persons with no work experience with a degree in computer science, math, physics, and engineering. There are also secretarial and technician positions open at this time.

I hope you can mention this in the L-5 News. I would rather see people here that are dedicated to a career in space, instead of people just holding down a job, and this is one of the few aerospace related firms that are hiring at this time.

Singer plans to have the new employees hired before August, so if there are some readers who can qualify, the opportunity is here now. I will be happy to correspond with any interested party, and help them in any way I can.

The jobs that exist here, in general, will not, unfortunately, qualify a person for mission specialist, but it does make you visible and accessible to the companies that can and to NASA.

The best job opportunities exist for those with experience or a master's or higher degree. The pay is not as good as can be obtained with firms not in the aerospace field (or even some that are), but it does get your foot in the door. It seems strange to me that the aerospace firms pay so poorly, but, if you're as interested in space as I am, it doesn't really matter that much.

Troy Welch
110 Woodlawn #41
Friendswood, TX 77546

L5 NEWS

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L-5 NEWS

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1 **Skyhook!** *Are mass drivers, solar sails and laser propulsion unusual space travel methods? Not compared to Hans Moravec's skyhook!*

3 **New Space Treaty Back in Limbo**

4 **OTRAG: Progress in the Face of Adversity** *Lutz Kayser, defying a Soviet-backed invasion aimed at his rocket company, has launched two more "Volksrockets". Carolyn Henson reports.*

7 **Zaire Missile Story Exposed as "Disinformation"**

9 **Space Settlements Conference** *Taylor Dark III reports.*

Careers in Space

Pioneers

10 **Close Encounter, Soviet Style**

Soviet Powersats?

Space Colonies Inevitable

Space Shuttle Main Engine Test Successful

Shuttle Vibration Tests

Update on Space Shuttle

11 **Space Processing: the "STAMPS" of Disapproval, or, Space Processing Takes it in the Ear** *Leonard David reports.*

12 **Bibliography Update** *by Conrad Schneiker*

13 **Inside the L-5 Society**

14 **Letters**

Cover: The planet Earth. Above the "L" is the Mediterranean; above the "W" is the Dead Sea.

Skyhook!

by Hans Moravec

A satellite in low circular orbit has two huge tapered cables extending outwards and rotating in the orbital plane, touching the planet each rotation. The tip velocity cancels the orbital velocity at the contacts, as in a rolling wheel. It can gently lift loads from the surface and accelerate them to escape velocity, and capture and lower speeding masses. Taper is minimized when the satellite's radius is one third the planet's, and for Mars and the Moon is reasonable with existing materials such as fiberglass and Kevlar.

The idea of a planet to orbit transportation system involving an enormous tapered cable extending from a synchronous satellite to the ground has been in the literature for almost two decades (1, 2, 3,). It has hitherto been considered applicable only in the distant future, when materials stronger than any now available come into existence.

This report points out that the combination of a new material, Kevlar (4) and a new, less expensive, satellite skyhook configuration (5, 6) makes skyhook transportation feasible now on bodies as large as Mars. On the moon, in particular, a Kevlar skyhook has enormous advantages over rockets for the supply and crew rotation missions envisioned for space industrialization efforts (7).

A synchronous skyhook is made by lowering a cable from a synchronous satellite to the surface, balanced by an even longer cable extending outwards from synchronous orbit. Anchored to the ground and put into tension by a ballast at its far end, it would be a cosmic elevator cable, able to deliver mass to high orbit with extreme efficiency, also providing a means for extracting the rotational energy of the planet. Such a structure cannot reasonably be built on Earth given existing structual materials. It would be possible if a cable with 10 times the strength/weight ratio of steel, or ⅛ the theoretical strength/weight ratio of crystalline graphite could be fabricated. A graphite cable with a density of 2.2 g/cm^3 and a tensile strength of 2.1x10^{11}dyne/cm^2 could be fashioned into a synchronous terrestrial skyhook which had only 100 times ground level cross section at synchronous orbital height. At any one time it could support one powered elevator massing 1/6000 of the cable mass (6).

Mars has a much shallower gravity well, and a synchronous skyhook for it is almost reasonable with conventional materials. Kevlar is a new superstrong synthetic from the DuPont Co. With a density of 1.44 g/cm^3 and a tensile strength of 2.76x10^{10}dyne/cm^2 it has about 5 times the strength/weight of steel. Stressed to half this, to build in a safety factor of two, Kevlar can be used to construct a synchronous martian skyhook with a taper of 16,000:1, able to support 10^{-6} of its own weight at a time. The numbers for the Moon, which has little gravity, but rotates very slowly, are 17.5:1 and 1/13,000.

The concept of a non-synchronous skyhook is illustrated in Figure A. A satellite in low circular orbit is elongated enough to just touch the surface in certain positions. It spins so that, like a rolling wheel, its rotation cancels its tangential velocity during the contacts with the surface. Such a structure can be constructed to orbit at any height, and a synchronous skyhook is a special case.

In very high orbits the forces on the cable must be integrated over long distances, resulting in large tapers. For very low orbits, the satellite must spin rapidly to keep the contact points stationary, and the quadratic dependence of centrifugal force on rate of spin results in a large taper in the limit. The taper is minimized between these extremes, when the radius of the skyhook is about 1/3 the radius of the planet.

An optimum size skyhook of this kind touches down six times per orbit. It is much smaller than the synchronous variety for the Earth, Moon, and Mars, but its length is still enormous by conventional standards. Because of its scale, its motion near the ground during touchdown is purely vertical. It appears to descend with a constant upward acceleration, coming to a gentle momentary stop, then ascending again. This acceleration is 1.4 gravities on Earth, 0.28 g on the Moon and 0.5 g on Mars.

A load attached to the bottom end of such a skyhook during a touchdown will be accelerated to a maximum of 1.6 times escape velocity at the highest point of the cable end's trajectory. Launching a mass in this manner extracts rotational and orbital energy from the skyhook, and lowers the orbit. Conversely, a high velocity craft which rendezvous with and attaches itself to the upper end of the cable, and is then decelerated and lowered to the ground, injects a similar amount of energy. Simultaneous docking of equal masses at both ends of a skyhook would leave the orbit essentially unchanged. The most plausible way to operate a device like this may be to have the cable ends merely approach the surface at a safe distance. A small rocket could be used to match the relatively tiny velocity and position differences between the cable tip and the ground. It would then be possible to borrow and deposit small amounts of orbital energy without risking collisions of the cable and surface.

Table 1 lists parameters for optimum size fiberglass and Kevlar skyhooks for some solar system bodies. Fiberglass is assumed to have a density of 2.5 g/cm^3 and a tensile strength of 2.41x10^{10} dyne/cm^2. Kevlar has a density of 1.44 g/cm^3 and a tensile strength of 2.76x10^{10} dyne/cm^2. Orbital period is how long it takes the skyhook to make a full circuit of the body. The liftoff acceleration is the vertical acceleration experienced by a skyhook payload near the ground, not including the surface gravity of the planet. It gives an indication of how long the touchdown lasts. "Taper" is the ratio in cross sectional area between the center of the skyhook, where it is thickest, and the tips, where it is thinnest. The "Mass" columns give the ratio between the mass of the skyhook and the largest payload that it can support at one time at each end. Thus a lunar Kevlar skyhook can lift 1/13 of its own mass. The numbers assume the skyhooks are stressed to at most half the strength of the material of which they are made, thus incorporating a safety factor of two.

Evidently Earth and Venus are too large for Kevlar skyhooks. Kevlar is strong enough for Mars, Mercury and all the moons of the solar system.

Some current plans for space industrialization call for transport of large quantities of equipment and people to and from the Moon. The proposed linear accelerator mass driver (7) is ideal for launching ore from the Moon. However, it provides no way of bringing payloads down to the surface, and with its 1000g accelerations and small mass unit is unsuitable for launching bulkier and more delicate loads.

A Kevlar lunar skyhook is able to lift and deposit 1/13 of its own mass every 20 minutes, and subjects payloads to a maximum of 0.45 g of acceleration. It would seem to be a desirable alternative to expensively fuelled rockets for routine supply and crew rotation missions to the Moon's surface.

References and Notes

1. Y. Artsutanov, **Komsomolskaya Pravda**, July 31, 1960 (contents described in Lvov, **Science** 158 946 [1967]).
2. J.D. Isaacs, A.C. Vine, H. Bradner, G.E. Bachus, **Science** 151 682 (1966) and 152 800 (1966) and 158 946 (1967).
3. J. Pearson, **Acta Astronautica** 2 785 (1975).
4. J.H. Ross, **Astronautics & Aeronautics**, 15-12 44 (1977).
5. The central idea in this paper, of a satellite that rolls like a wheel, was originated and suggested to me by John McCarthy of Stanford.
5. H.P. Moravec, **Advances in the Astronautical Sciences**, 1977, also **J. Astronautical Sciences** 26 (1978).
7. G.K. O'Neill, **The High Frontier, Human Colonies in Space** (William Morrow & Co., New York, 1976).

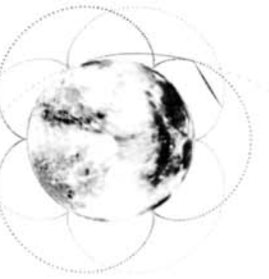


Fig. C. A trajectory which takes a mass launched parallel to the lunar surface by a mass driver to a rendevous with the tip of an optimum sized lunar skyhook. At the instant of contact the position and velocity of the mass and the skyhook end are identical. Only the accelerations differ. By catching such a mass and releasing it at a later time the skyhook gains or loses varying amounts of orbital and rotational energy. The starred and dotted paths mark the trajectories of the two ends of the skyhook. The dashed line is the orbit of the launched mass in case it is not caught by the skyhook. The solid portion of this orbit is the actual path from the mass driver to the skyhook. The skyhook is shown at the instant of capture. It is then about 1 degree off horizontal.

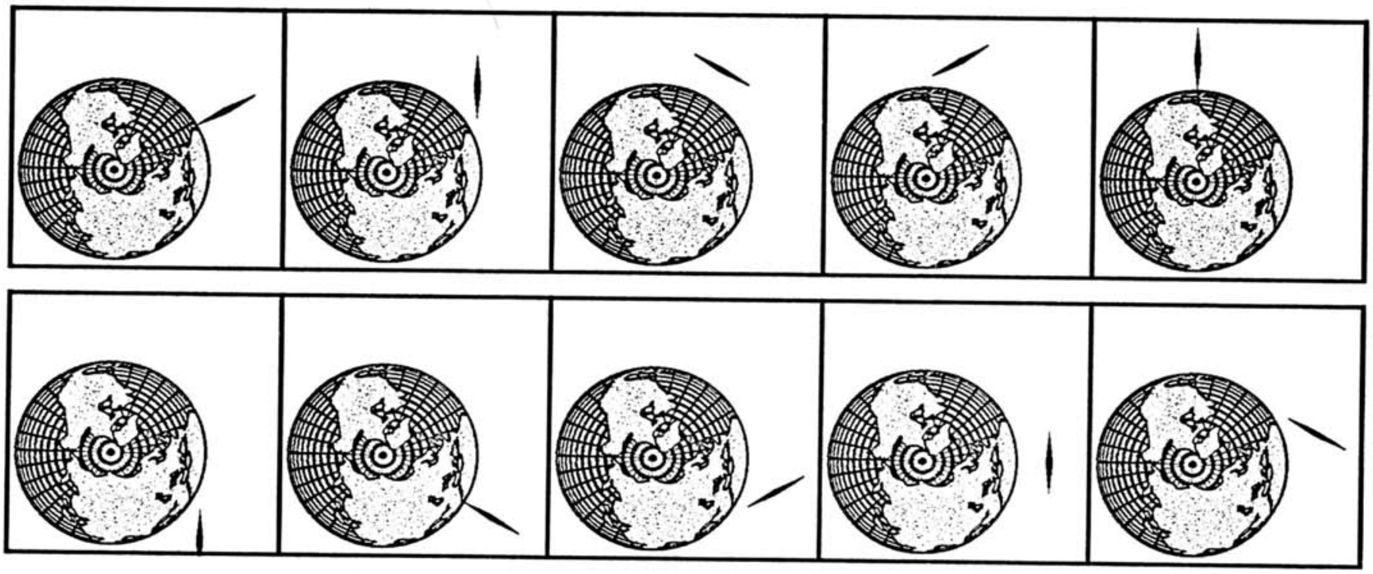


Fig. A. *A non-synchronous skyhook's progress around a planet: two spokes of a giant wheel.*

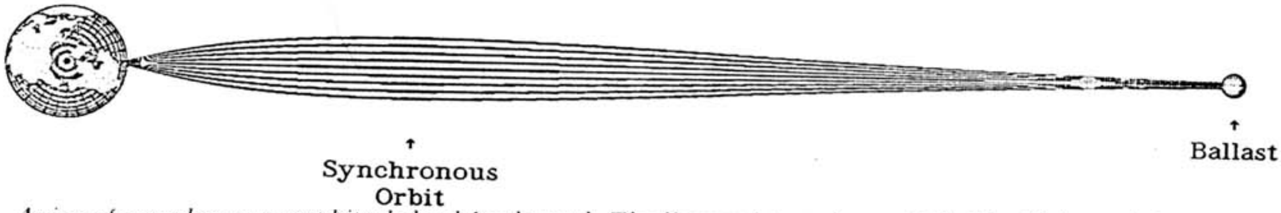


Fig. B. *A view of a synchronous graphite skyhook for the earth. The diagram is to scale, except that the thickness of the cable has been greatly magnified.*

TABLE I. Parameters for Optimally Sized Skyhooks

Body	Orbital Period (hr.)	Liftoff Accel (g)	Fiberglass		Kevlar	
			Taper	Mass	Taper	Mass
Mercury	2.37	0.57	2200	23000	49	350
Venus	2.37	1.39	1.2×10^{20}	3.0×10^{21}	1.3×10^{10}	2.3×10^{11}
Earth	2.16	1.40	7.2×10^{21}	1.9×10^{23}	1.0×10^{11}	1.9×10^{12}
Moon	2.78	0.28	13	72	3.6	13
Mars	2.62	0.49	17000	200000	136	1100
Ganymede	3.41	0.26	35	240	6.0	28
Titan	3.39	0.26	29	190	5.4	24

New Space Treaty Back in Limbo

The meeting of the UN Outer Space Committee June 26 to July 7 consigned the "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" back into limbo. This came as a relief to those space industry researchers who consider some provisions of the treaty draft to be untenable.

One of the members of the U.S. delegation to the Outer Space Committee told the **L-5 News** that it is unlikely that a final version will be reported out of the Committee for at least two more years.

For a detailed discussion of the treaty draft, see "Responses to 'Space Mines' ", July 1978 **L-5 News.**

Delegations of the US and the USSR held consultations in Helsinki from June 8 through June 16, 1978 to discuss questions in connection with limiting certain activities directed against space objects and incompatible with peaceful relations between states, including the means and systems for conducting such activities.

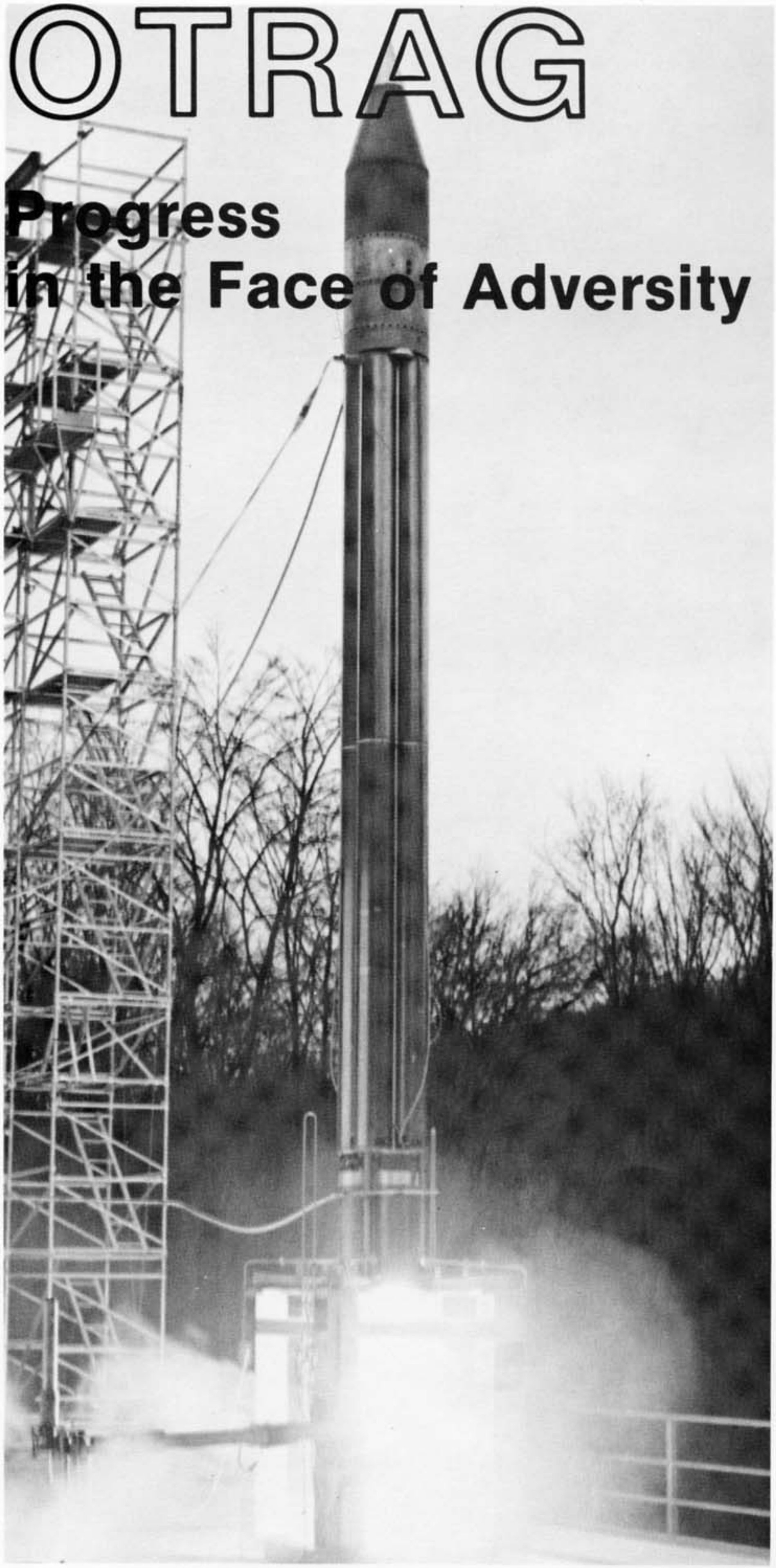
The US Delegation was headed by Ambassador Paul C. Warnke and the USSR Delegation was headed by Ambassador Oleg N. Khlestov.

The consultations were of a preliminary nature, and enabled each side to understand better the views of the other on these questions.

These discussions will be continued. The exact date of the next session will be determined through diplomatic channels.

OTRAG

Progress in the Face of Adversity



by Carolyn Henson

The primitive wooden gantry used for their first rocket launch, May 17, 1977, has been upgraded to a steel structure. But OTRAG's 100 plus employees make their homes in thatched huts, and the two Argosy airplanes that link them to the outside world still lumber down a dirt runway. The OTRAG compound atop the Manono plateau in the Shaba province of Zaire seems an unlikely place to be the focus of a controversy spanning four continents and embroiling the world's superpowers.

Target of Shaba Invasion

For nearly a year the Soviet Union and allies have been attacking the West German private company OTRAG (see "German Space Capitalist Under Attack", **L-5 News**, December 1977). The U.S. publication **Penthouse** joined the chorus December 15 with a rewrite of an article from the French marxist publication **Asie Afrique** which alleged that OTRAG was a cover for a German/U.S. cruise missile development facility (see "OTRAG News", pp. 12, 13, **L-5 News**, April, 1978).

This May the attacks became a bit more physical. Announcing that OTRAG is "a serious and permanent threat to the whole of Southern Africa", Soviet-financed General Nathaniel Mbumba led his FNLA troops in an invasion of Shaba province. Although the fighting never got closer than Kolwezi, 150 miles from the OTRAG launch site, the **London Observer** reported that OTRAG had evacuated shortly after their successful second test launch May 20. That vehicle, composed of four 12 meter long tanks of three tons thrust each, achieved an elevation of nearly 80 km.

Shortly after NATO troops quelled the invasion OTRAG geared up for a third "Volksrocket" test. Zaire president Mobutu Sese Seko was on hand to witness its June 5th launch, as well as reporters from **Time** and **Newsweek**. As the accompanying photos show, the visiting dignitaries were treated to some unplanned, albeit peaceful, fireworks. OTRAG engineers pronounced the test a success (shades of Cape Canaveral back in 1958!).

A NATO Front?

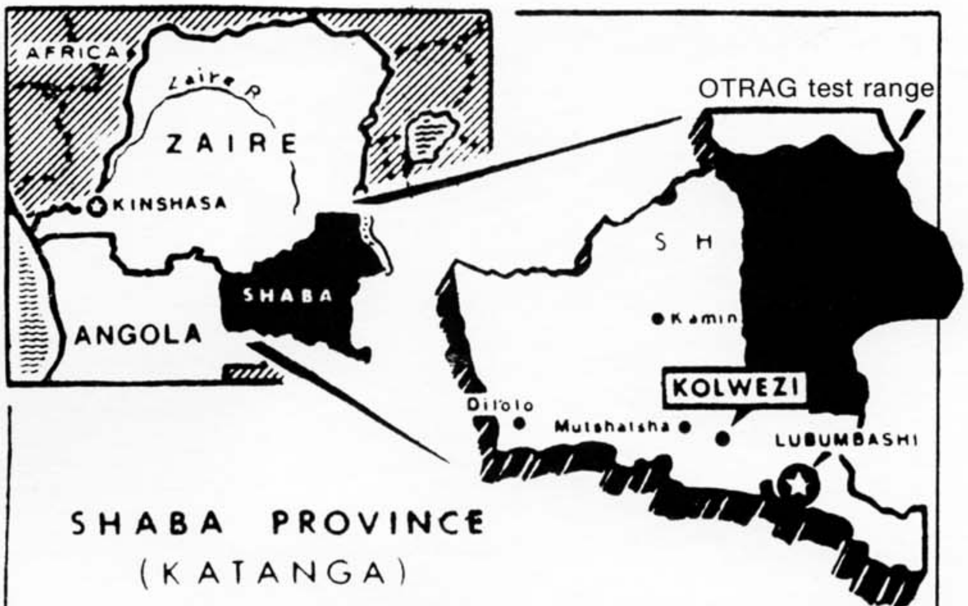
Meanwhile, in a speech before the UN General Assembly June 1, Angolan prime minister Lopo do Nascimento (who is believed by some to have engineered the Shaba invasion) asserted that "...the West

German testing range is the barrel of a pistol aimed at the heart of Angola". Over in France, **Le Monde** charged that the NATO intervention in the FNLC invasion of Shaba was motivated by a desire to protect OTRAG. TASS, the Soviet news service, claimed that "...the speeded-up implementation of an extensive program of rocket tests in the testing range in Zaire is part of a unified plan drawn up in NATO . . .".

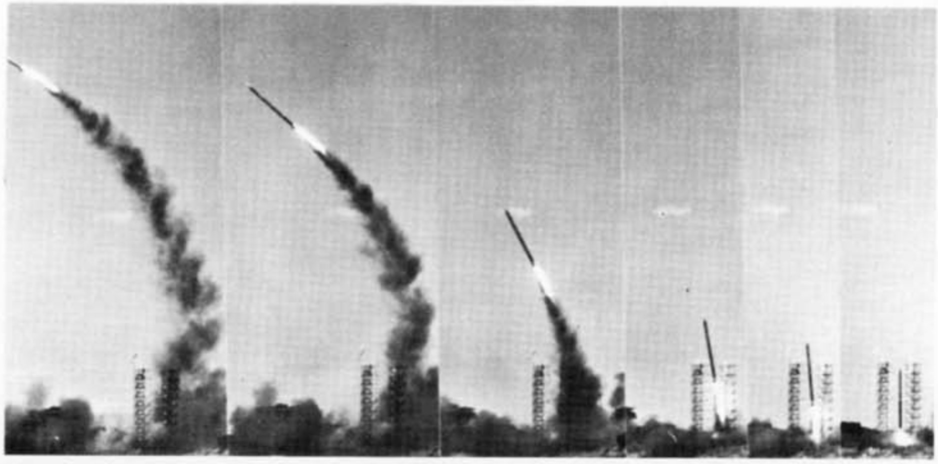
What connection does OTRAG have with NATO governments? Lutz Kayser and a group of five other engineers received $1.8 million from the West German government over a three year period for rocket research. In 1974 his funds were cut off. Undaunted, Kayser fired up OTRAG and convinced retiring Kennedy Space Center director Kurt Debus to become chairman of the board. OTRAG investors were given a special tax break by the Bonn government, which has aided them in raising $40 million to date. Kayser expects to need another $200 million before OTRAG lofts its first commercial payload into orbit in 1980 or 1981.

However, **Aerospace Daily**, June 2, pp. 183-4 reported that, due to export delays and a recent souring of their relationship with the German government, OTRAG has established a Paris branch; L-5 correspondent Theo Pirard also reports formation of a New York branch. But their German problems pale before the uncertainties of their situation in Zaire. The Coco Beach, Florida paper **Today** reports Kurt Debus as saying OTRAG is "...actively looking for a new launch site...", adding that "I can't tell you where the sites are, but I will say one which is under consideration is in South America."

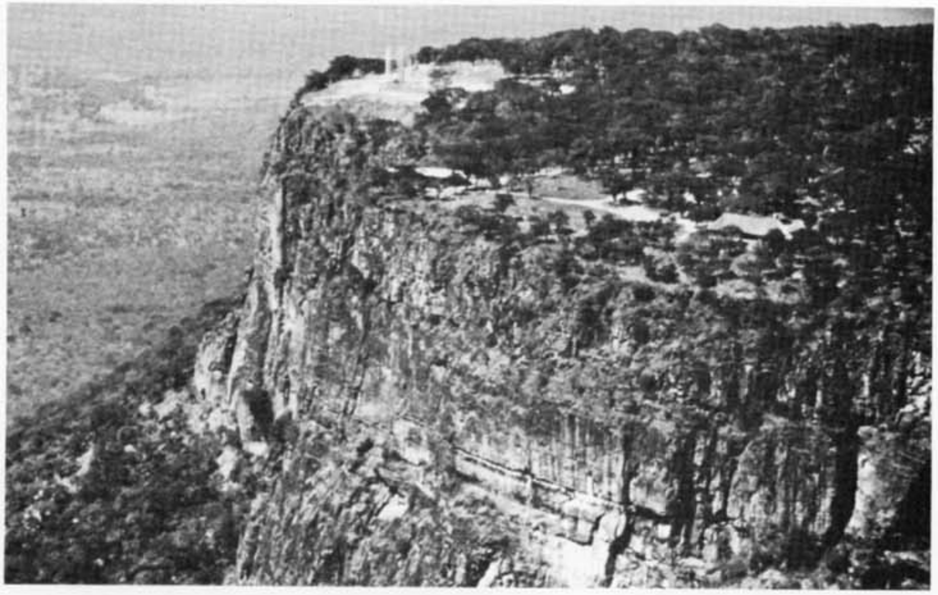
Поливочные работы.
Country is Zaire, helmet is "NATO", letters on missile are "OTRAG" and the caption is "WATERING". (This clipping from the June 27, 1978 **Pravda**, pg. 5 is courtesy James Oberg.)



Fighting in the FNLC invasion reached Kolwezi.



A stuck valve in one of the four clustered engines caused the third rocket launched to arc over for a spectacular crash in the Luvua river valley.



The OTRAG launch facility, located on the Manono plateau. Below is the Luvua river valley.

The Chinese Connection

Some observers speculate that the motivation for the Soviet/FNLC campaign to eliminate OTRAG is the rocket firm's agreement to launch reconnaisance satellites for arch-rival China. The Soviet camp's fears of the Chinese connection were strengthened by the visit of Chinese foreign minister Huang Hua to Lumbumbashi, capital of Shaba province, shortly after the fighting ceased. **Newsweek** reported that the Chinese now plan to beef up Zairean defenses with "small arms, mortars and artillery pieces, and perhaps even Chinese instructors".

The Soviets were predictably outraged. TASS charged that Peking, "...instead of condemning NATO's intervention in Zaire, has slandered the Soviet Union and Cuba by accusing them of 'interfering' in the affairs of African peoples...The imperialists and Maoists are playing the same tune in an attempt to confuse the African people with plainly false music".

The international furor OTRAG has aroused stands as a warning to would-be space entrepreneurs. Pioneering has never been easy. Yet throughout history people have met the challenge. What will historians write about the pioneers of space?

Director of OTRAG and inventor of its "space truck", Lutz T. Kayser.

Housing for OTRAG employees.

Sophisticated rocket tank transportation method.

"Argosy" airplanes, used by the OTRAG Range Air Service.

Zaire Missile Story Exposed As "Disinformation"

Claims of West German cruise missile tests in Zaire are a fraud, according to the July issue of **Reason** Magazine.

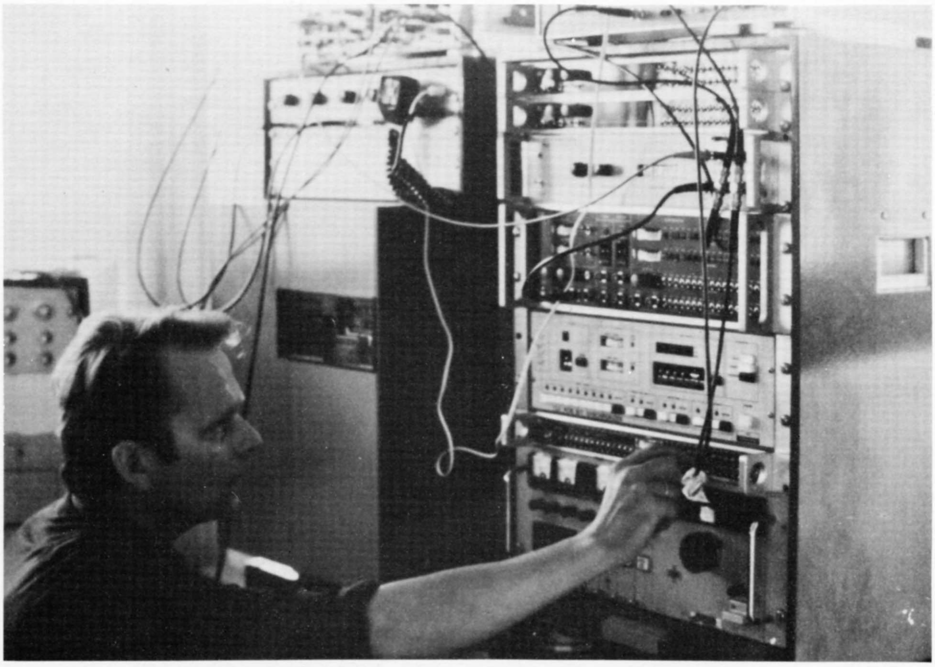
The magazine, responding to a story by veteran reporter Tad Szulc in the March issue of **Penthouse**, presents evidence of a joint U.S./Soviet disinformation campaign on the subject, about which Szulc was apparently unaware.

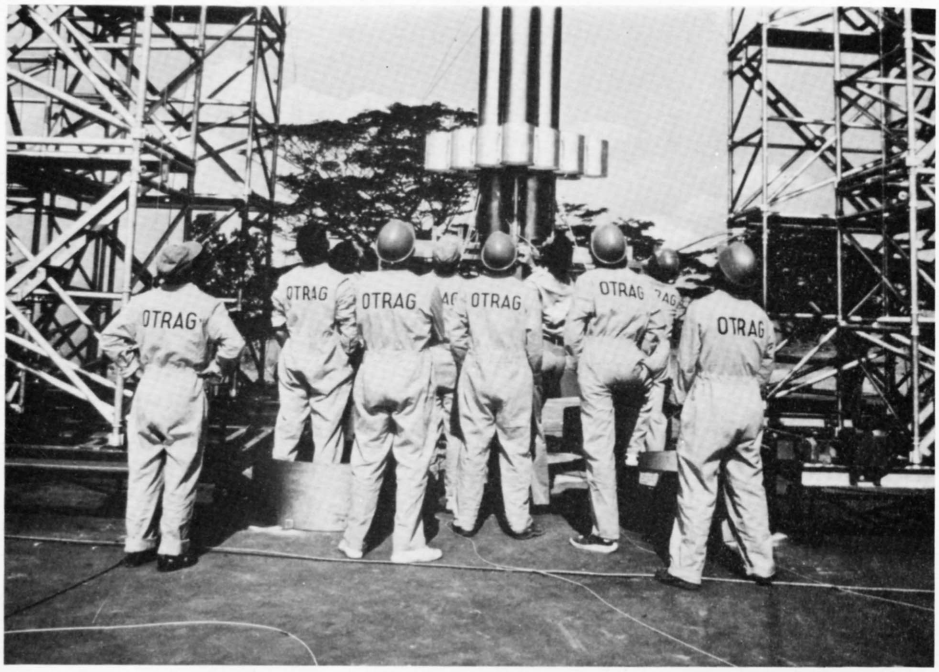
Reason editor Robert Poole, Jr., author of the article "African Deception," says that the purpose of the disinformation campaign is to preserve a two-power monopoly on reconnaissance satellites.

"This is another shameful attempt by government to manipulate the press," says Poole. "What Washington cannot accomplish by straightforward means, it is seeking to bring about by 'leaks' of lies and distortions."

Szulc's story, citing U.S. intelligence sources, claimed that the West German government is secretly testing cruise missiles at a base in Zaire's Shaba province. Its cover, the **Penthouse** article asserted, is a private company called OTRAG, ostensibly researching weather satellites.

Poole's article documents numerous errors and inconsistencies in Szulc's piece. Szulc claims that OTRAG's operations are veiled in secrecy--yet its first launch was broadcast on German television and promoted by a PR firm. He lists the size of OTRAG's test range as "a 100,000 square mile area (the size of Colorado)"--when it is actually only 100,000 square kilometers, about one-third that size. His evidence that West Germany has produced a cruise missile is limited to a photograph displayed at the 1977 Paris air show--which more than likely depicted a German remotely piloted vehicle (RPV).


OTRAG control center.



OTRAG rocket assembly team.

Checking further into OTRAG's "cover story," Poole learned that the company's intent is not to research weather satellites but to provide a commercial satellite launching service. Its intended customers are Third World governments that wish to launch satellites for communications and reconnaissance purposes.

If OTRAG succeeds, notes Poole, it would be competing directly with NASA's Space Shuttle and the European Space Agency's Ariane booster. OTRAG has also aroused fears of the Soviet Union, which has stridently denounced it as a front for West German military missile testing.

Szulc wrote that he had been told the same thing by his contacts in U.S. intelligence circles. Yet neither the U.S. nor the USSR—both of which have closely observed Zaire via reconnaissance satellite —have produced any evidence that military missiles are being tested there.

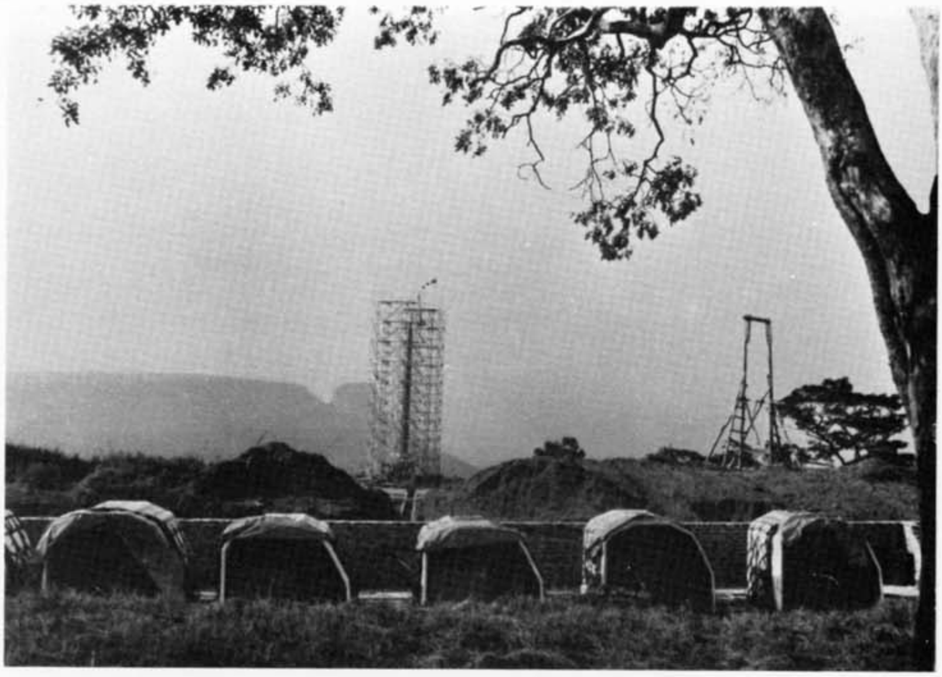
Why, Poole asks, would U.S. officials leak such a story, given the solid evidence that OTRAG is actually a commercial enterprise? The answer, he claims, stems from OTRAG's willingness to launch reconnaissance satellites for any and all customers. The firm has been approached by the Chinese government, and has said that it would have no objections to launching a Chinese reconnaissance satellite. OTRAG could thus break the monopoly on launching such satellites shared by the U.S. and the USSR.

Officials of both powers have proposed steps to limit the reconnaissance data available to third parties. The USSR is even pushing for a UN treaty to ban any other nation from launching reconnaissance satellites.

"But if reconnaissance satellites become available to all nations, the Big Two will no longer be able to dominate international affairs as completely," says Poole. "In every recent Middle East crisis, for example, U.S. intelligence has supplied the Israelis with up-to-date reconnaissance data from its Big Bird satellites. The ability to *withhold* such information provides an incalculably valuable lever for influencing the affairs of others. Reconnaissance satellites give new meaning to the old adage that knowledge is power."

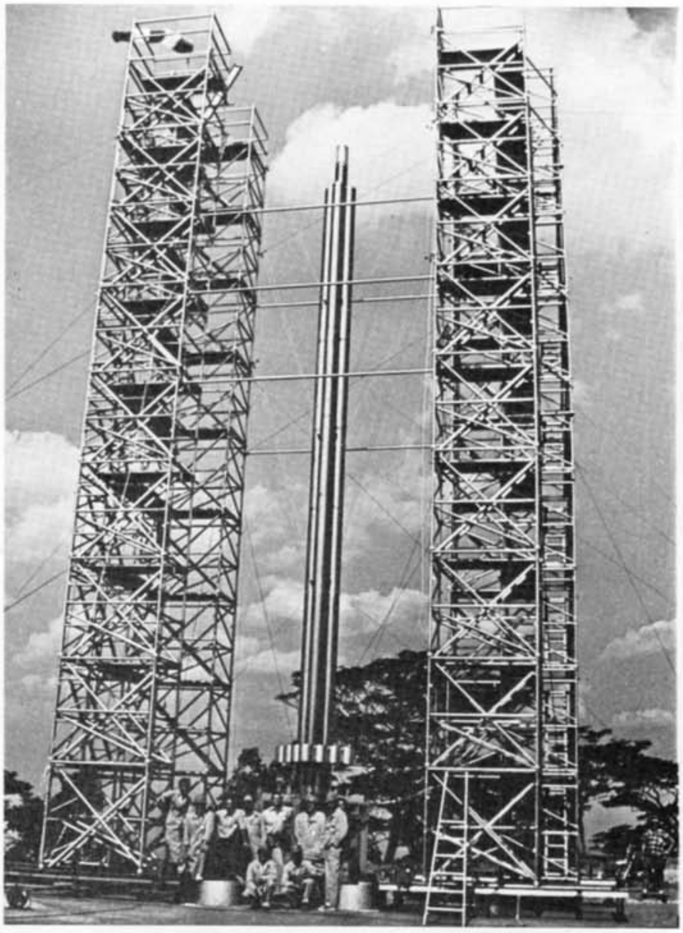
Hence, claims Poole, it is not at all surprising that U.S. officials would leak disinformation about OTRAG to Szulc, to protect the two-power monopoly. Poole urges U.S. officials to "back off from their disinformation campaign" and "firmly oppose the Soviet proposal to prevent other nations from acquiring reconnaissance satellites." Poole thinks the chances for peace will be increased "when Israel *and* Egypt, Greece *and* Turkey, Iran *and* Saudi Arabia, Peru *and* Chile all have their own reconnaissance capabilities."

Reason is a monthly magazine of analysis and commentary on current issues. Editor Robert Poole, Jr. holds two degrees in engineering from MIT and has worked for several aerospace and defense firms.

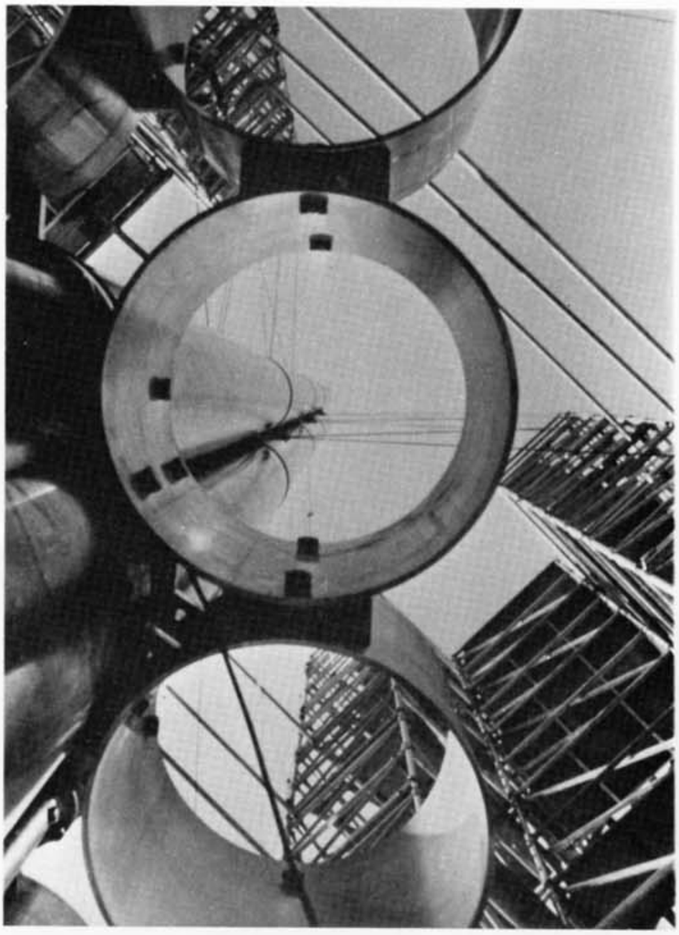


Propellant storage tanks in foreground contain nitric acid and kerosene. Center is the new gantry; to the right is a relic of OTRAG's earlier days.

All photos with this article were provided by Theo Pirard, of the Centre D'Information Spatiale, Pepinster, Belgium.



The third OTRAG test rocket.



Mass produced tube fins for aerodynamic stability.

Space Settlements Conference

by Taylor Dark III

"We've been though an extremely rugged year, politically. I think we've turned the corner. It's (the space settlement movement) become established. I think it's safe to say that the work cannot be cut off, although we are far from the situation where there's a big political push to move ahead. But the more pressure we build up with these kinds of expert technical studies, which we heard about today, the more there will be the readiness so that when the political key goes into the lock, the lock will be well oiled and will open easily. And that, of course, is what we all hope for."

So said Gerard K. O'Neill in an impromptu speech at the conclusion of the Jet Propulsion Laboratory/Caltech Conference on Space Settlements. Held in late July, the conference consisted of nine speakers who described various aspects of space colonization and industrialization.

Several participants, including former astronaut Brian O'Leary, discussed at length the advantages and disadvantages in using either the asteroids or Moon as a source for materials from which to obtain Earth independence. O'Leary called asteroids "the most abundant source for materials (from which) to obtain Earth independence." O'Leary felt the asteroids could supply enough metals so that eventually processed metal could be transported down for use on Earth. Others contested his claims, though, saying that the asteroids were either too far away for immediate use or lacked enough of the proper minerals.

In a presentation entitled "Steps to the High Frontier", Jim Burke of JPL divided the future of space utilization into three areas. First was scientific investigation, second was technological development, and third was the loosely defined category of "leadership". Within this, Burke called for commercial space entertainment to heighten interest, as Star Wars did, in the space program; and for increased education, publicity and political action. He also supported genuine training and support for those already involved in the space program, and for a reduction in defense spending between the U.S.S.R. and the United States so more money could be used constructively in space.

The final speaker was J. Peter Vajk, who made a presentation that was geared for those in the business world interested in the concepts of solar power satellites and space manufacturing. In a step-by-step fashion, Vajk outlined exactly how and in what amount of time each phase of a space industrialization program would be carried out.

Careers in Space

Do you want a career researching space settlements, industries or solar power satellites? Where can you study these? The following colleges and universities have research projects or teach courses on these topics.

Massachusetts Institute of Technology
Dept. of Aeronautics and Astronautics
Cambridge, Massachusetts
Contact: Rene Miller
Topics: large space structures, solar power satellites, space habitat construction, mass drivers

California Institute of Technology
Pasadena, California
Contact: Eleanor Helin
Topic: asteroidal resources
Jet Propulsion Lab
Contact: R.M. Dickinson
Topic: microwave power transmission for SPS

University of Arizona
Environmental Research Lab
Tucson, Arizona
Contact: John Phillips, Annita Harlan
Topic: space agriculture

Georgia Institute of Technology
Chemical Engineering Dept.
Contact: John Cardin
Topic: space agriculture

Rice University
Physics Dept.
Houston, Texas
Contact: John Freeman
Topic: solar power satellites

Princeton University
Physics Dept.
Princeton, New Jersey
Contact: G.K. O'Neill
Topic: mass drivers

Georgetown University
Graduate School
Washington, D.C.
Contact: Stephen Cheston
Topic: social aspects of space settlements

California State University
Sociology Dept.
Northridge, California
Contact: B.J. Bluth
Topic: social aspects of space settlements

SPACE - ORIENTED INDIVIDUALS are invited to send resumes for eventual consideration for employment with wide ranging project. We anticipate several job openings in the coming year. No aerospace or technical background required. All fields welcome. Send to: Sabre Foundation, Earthport Project, 221 W. Carillo St., Santa Barbara, CA 93101.

Pioneers

Have the elder races halted?
Do they droop and end their lesson,
wearied over there beyond the seas?
We take up the task eternal, and the burden
and the lesson,
Pioneers! O pioneers! . . .

O resistless restless race!
O beloved race in all! O my breast aches
with tender love for all!
O I mourn and yet exult, I am rapt with
love for all,
Pioneers! O pioneers! . . .

Lo, the darting bowling orb!
Lo, the brother orbs around, all the
clustering suns and planets,
All the dazzling days, all the mystic nights
with dreams,
Pioneers! O pioneers!

—*Walt Whitman*

"Today . . . as other nations aggressively pursue space initiatives, I detect a reluctance on our part to establish future goals and clear directions that will assure our leadership 5, 10, 15 and 20 years from now.

"Our present course, if not altered, may well cost us the leadership posture in space science and technology that we have attained—at no small expense. We are on the verge of frittering away this unique opportunity."—*Senator Adlai Stevenson*

Soviet Powersats?

Do the Soviets have a solar power satellite program? At a recent conference in honor of Soviet cosmonauts' record-breaking stay in the Salyut-6 space station, pilot-cosmonaut Konstantin Feoktistov discussed the SPS concept. He stated that the idea is "not unrealistic" and proposed that they may become a reality "within several decades". He reminded listeners that SPS will require the moving of millions of tons of materials and equipment into space and hundreds of people on the scene to maintain them.

Space Colonies Inevitable?

Space colonies are inevitable, according to Iosif Shklovsky, a Soviet astrophysicist and member of the Soviet Academy of Sciences. Writing in the journal **Social Sciences**, he bases his prediction partly on his belief that solar power satellites will provide an impetus for the creation of human settlements in space.

Following what is often called the "O'Neill line", Shklovsky pointed out that it would be necessary to use raw materials from the Moon and asteroids.

Update on Space Shuttle Schedule

Since 1973, the first shuttle orbital flight has been officially scheduled for the second quarter in 1979. An internal NASA working schedule of March 1979 was set the same time.

Most of the major elements of the program are between two and three months behind the target schedule of March 1979 but are still able to meet the commitment schedule of June 1979. The one element of the system which could cause the June date to slip is the main engine. Though the June date allows sufficient time to complete the engine hardware and necessary engine development and qualification tests, it does not allow any slack for additional major main engine test failures. The Space Shuttle main engine tests scheduled between May and September 1978 should provide NASA with sufficient insight on potential engine problems to reschedule in September 1978, if a rescheduling is required.

Close Encounter, Soviet Style

The Soviets nearly had a space fatality last December when Cosmonaut Yuriy Romanenko took an unauthorized space walk.

At a press conference held at Moscow State University fellow Salut-6 Cosmonaut Georgiy Grechko revealed ". . . some details we did not report to Earth . . . I hope the flight directors will not be offended, but we concealed (the fact) that not only the flight engineer went out into space, as was called for in the program, but also Yuriy Romanenko. It was very difficult, naturally, for him to restrain himself. Yura, it is true, had forgotten to fasten his safety line, and I had to take hold of this line and restrain the commander".

If Grechko had not caught the tether, Romanenko would have drifted off forever in his own lonely orbit.

What caused Romanenko's close encounter with death? **Time** magazine, July 3, 1978, speculated that he was overcome by "space rapture". However, an expert on the Soviet space program at Johnson Space Center, Jim Oberg, speculates that "He stood up (at the control panel inside the open hatch) and lost his grip, while just intending to have a peek."

Oberg concludes, "The **Time** story is garbled and dramatized but essentially accurate—the Russians nearly had a space fatality last December".

Shuttle Vibration Tests

The first phase of the Space Shuttle ground vibration test series began May 30 in a tall test tower at NASA's Marshall Space Flight Center. The tests followed installation in the stand recently of the Space Shuttle's external tank and orbiter *Enterprise* in late April.

The tank and the orbiter were "soft-mounted" inside the stand through use of a system with air bags and cables that suspends the vehicles from a large overhead truss installed like a crossbeam between two test stand walls. It was the first time these two major components of the Shuttle have been mated as they will be for actual flight.

Engineers then installed the system which applies vibrations to the Space Shuttle as it hangs vertically in the test stand. Called the "shuttle modal test and analysis system," the computerized system can provide the required vibrational cycles and force inputs as well as acquire the response information from the vehicle.

The term "vibration" could mislead—the system does not shake to learn how strong the vehicle is. Instead engineers apply vibrations to the exterior with exciters powered by amplifiers similar to those found on home stereo sets. Sensors then record the characteristics of the vibrations as they pass from one area of the vehicle to another.

Space Shuttle Main Engine Test Successful

Three Space Shuttle main engines roared to life May 19 in the first major test firing of the Shuttle's main propulsion system. Orange flame and a huge cloud of white steam and smoke poured from beneath the test stand in which the cluster was held firmly to Earth during the noisy 15-second run.

That running time was considerably longer than the cluster's only previous firing, a one-second ignition test on April 21. The engines reached 70 percent of their rated power during this test.

Bob Lindstrom, Space Shuttle projects manager at NASA's Marshall Space Flight Center, where the engine is being developed, said after the firing that everything went as planned. "We haven't evaluated all the data," he explained, "but from what we can see, we have a very successful test."

The test firing took place in Bay St. Louis, Miss., at NASA's National Space Technology Laboratories. The test program is managed by the Marshall center and conducted by the Rockwell International Space Division.

During the next several months, additional tests will increase the duration of firing and the engine thrust levels until they are fired at 109 percent of rated thrust for about eight minutes at a time. This will simulate an actual Space Shuttle mission into space.

Space Processing: the "STAMPS" of Disapproval or Space Processing Takes it in the Ear?

By Leonard David/FASST News Service

A special study by the National Academy of Sciences (NAS) has concluded that the prospects for economical space manufacturing are "limited and need to be better defined on a case-by-case basis." Further, the NAS Committee on Scientific and Technological Aspects of Materials Processing in Space (STAMPS) reports no examples of "economically justifiable processes for *producing* materials in space," could be found. NASA should not emphasize this area of materials technology, recommends the Committee. The study was funded by NASA.

The NAS report was developed by an interdisciplinary group, comprised of members from national laboratories, universities and industries. A majority of the group had little or no previous involvement with NASA. The 12-member team was led by Dr. William P. Slichter, Director of Research for the Bell Laboratory's Materials Science and Engineering Division. An earlier draft of the final report was even more critical of the space processing concept.

In effect, the STAMPS study has slapped NASA's hand, pointing out that early work by the space agency in processing materials in space "has suffered from some poorly conceived and designed experiments, often done in crude apparatus, from which weak conclusions were drawn and, in some cases, over-publicized." Although not contained in the report, it is known that Committee members included the production of perfect ball-bearings in zero-gravity as being completely over-sold. This should be particularly interesting to the German company Volkswagon. Volkswagon is in the process of developing experiments for space production of bearings for use in an automobile with a 200,000 mile engine guarantee!

The NAS Committee stressed two points that emerged from the testimony of its advisors and from previous materials experimentation in space. "First, the space environment usually contributes at least as many problems as it solves. In sophistication, reliability, convenience, and cost, terrestrial experimentation is generally superior to what can be expected in space. Second, space experimentation will have little value unless its planning is founded on substantial Earth-based information and unless the results are coupled to those of complementary terrestrial programs."

The report indicates that some space environments, such as the level of vacuum, temperature, or high-energy radiation can "be realized better and more easily on Earth." The best advantage of the space environment is, of course, the long periods of low gravitational acceleration, only achieved through orbital flight. But even in this instance, cautions the NAS Committee, future "zero"-gravity Space Shuttle processing experiments may be jeopardized by several factors. Among these are: gas venting, fluid dumps, use of evaporators, crew motions, and perturbations of the Shuttle orbit itself. These factors could induce accelerations, creating small forces of gravity, in turn affecting the low-gravity requirement of space processing.

Singled out in the report were commercial space processing of vaccines using electrophoresis (the separation of particles of different mass/charge ratios in an electric field) and growing silicon crystals for use in electronics. The NAS study found no clear-cut advantage in either case over terrestrial processes. In the case of electrophoresis, use of the technique on Earth has not yet been optimized.

But all is not grim in space-processing land. After the year long study, Committee members report that some valid experiments can be conducted in space. Concludes the study group, low gravity appears to offer certain capabilities in studying the properties of boiling, combustion and melting, processes which are not now well understood. The prospects for containerless processing, to avoid contamination and increase purity, may hold great promise, feels the Committee. But even these possibilities must be subject to critical evaluation of comparative costs and likelihood of success. The NAS study group indicated that the commercial utilization of such understanding lacks promise.

Reaction to the STAMPS report by NASA is mixed, with one official stating "we found nothing objectionable in the study." Others felt that NASA did not get its $180,000 worth, pointing out the study group's inability to gather and review previous reports on space processing experimentation. James Bredt, Manager of Space Processing Applications for NASA, views the STAMPS review as a "kind of non-comment." The fact that the STAMPS Committee did find some good science can be conducted in space "is a victory" feels Bredt. "We faced a hanging jury and got acquitted," concludes Bredt.

The organization and management of future space processing should include the use of the Space Shuttle as an orbital national facility, suggests the Committee. This facility would include use of the Spacelab by scientists and engineers working in universities, government laboratories, or industrial concerns. User rates will be established, but not designed to cover the total real cost of operating the facility.

However, such a plan can be instituted only after a period of perhaps five or more years of careful experimentation—to develop and demonstrate significant material processing techniques. The cost of such early research should be paid for by NASA, felt the NAS panel members. To this end, the Committee suggests certain technical and management changes to improve the effectiveness of the NASA materials space processing program.

The NAS Committee will meet again within a year to evaluate progress of NASA in implementing the study's recommendations.

Leonard David is Program Director for the Forum for the Advancement of Students in Science and Technology (FASST).

First Spacelab Science Team Selected

Two Americans have been named by NASA as part of an international group of five scientists who will serve as payload specialists during the first Spacelab mission which is scheduled for the latter part of 1980.

The American payload specialists were nominated and selected by the Investigators Working Group (IWG), which is composed of scientists representing all investigators.

The selectees are:

- Dr. Michael L. Lampton, 37, of Berkeley, Calif., a space physicist at the University of California, Berkeley.
- Byron K. Lichtenberg, 30, of Natick, Mass., a vestibular researcher at the Massachusetts Institute of Technology, Cambridge, Mass.

One American and one European eventually will be selected to fly aboard the Earth-orbiting space laboratory and operate the science instruments.

Payload specialists are new to the space program. Their responsibilities will be to perform experiments in space aboard NASA's Space Shuttle, which will carry the European-built Spacelab into Earth orbit. Payload specialists are not pilots, and are not to be confused with mission specialists. The latter are crew members responsible for *all* aspects of the Shuttle flight except piloting.

The three payload scientists who are not chosen to fly in space will act as backup specialists, participating in ground-based mission activities at NASA's Johnson Space Center during the flight. That choice will be made some months before the flight.

The American payload specialists named this week were selected from a list of six finalists. The European scientists, announced last week, were selected by the European Space Agency (ESA) from among thousands of applicants in its member states after parallel screening programs were conducted in Europe.

The three payload specialists selected by ESA are:

- Ulf Merbold, 36, German, a scientist at Max Planck Institute, Stuttgart, West Germany.
- Claude Nicollier, 33, Swiss, a scientist and pilot at the European Space Technology Center (ESTEC), Noordwijk, Netherlands.
- Wubbo Ockels, 31, Dutch, a physicist at Groenigen University, Netherlands.

The first Spacelab will be launched aboard the Shuttle from NASA's Kennedy Space Center in Florida. It will orbit the Earth at an altitude of 250 kilometers (155 miles). At the end of the seven-day mission, the Shuttle will return for a runway-type landing at the Kennedy Center, be serviced and readied for other missions.

NASA's Marshall Space Flight Center is responsible for the payload specialists' training activities as part of its overall management responsibility for the Spacelab mission. ESA's Spacelab Payload and Coordination organization in Europe will manage training activities in Europe.

BIBLIOGRAPHY UPDATE

by Conrad Schneiker

"Lasers: One Answer to Sending Solar Power", Thomas A. Gorski
NSI Newsletter, April 1978
Builds a case for using laser beams instead of microwaves for energy transmission from solar power satellites. A long list of potential advantages are cited. First, much smaller satellites are used. This greatly reduces military vulnerability and greatly reduces start-up costs—very important points. Ground receivers are small (10-20 meters) and power can be delivered closer to consumers. Beams may be easily split to serve smaller markets. The large number of small transmitters provides greater redundancy, minimizing effects of breakdowns. Public fears of safety may be reduced by not using microwaves and the use of physically small optics can make military diversion impractical. Its claimed use of 2 micron (infra-red) wavelengths can eliminate danger of eye damage and minimize atmospheric and ionospheric absorption. Light cloud cover will not affect the system adversely and really bad weather can be circumvented by the existing power distribution network. Special sensors and adaptive optics can react "instantaneously" to eliminate danger to spacecraft and satellites. As for efficiency, when the initial conversion of sunlight into microwaves is included in overall efficiency calculations, the laser power system's overall efficiency looks about the same. Dr. John D.G. Rather of Schafer Associates proposed this idea and estimates that 2 or 3 space shuttle flights can deploy a complete power module. A fantastic idea if it's really as good as it's made out to be. It would be even better if it can be used to directly drive laser amplifiers for earth-to-GSO laser-launch systems. Note that the test ground receivers (the DOE's solar towers, etc.) are already built and stand waiting to be used every night. If any reader can dig up more information on this subject, please forward it to me c/o **L-5 News.**

"Should The U.S. Switch To Solar Power?" Ray Connolly
Electronics, April 27, 1978
Describes congressional committee debates on the pros and cons of solar power satellites. It's interesting to note that people on both sides of this issue generally concur that the technology is already available and the major (but tractable) engineering problem is the in-orbit assembly of large space structures. An editorial in the same issue of **Electronics** comments on the reluctance of DOE to accept money (!) to accelerate SPS R&D. As one Congressional staffer put it: "I don't get it."

"Sunny Future for Power Satellites"
Ian Ridpath
New Scientist, May 25, 1978
A short article describing Earth-launched solar power satellites.

"Advanced Launch Vehicle Systems And Technology," M.W. Jack Bell
Spaceflight, April 1978
Escalating costs, increased competition, and pollution worries all motivate the search for post-shuttle launch vehicles. This article examines second generation launch system concepts and identifies the required technology. Although the basic capability now exists to initiate development of an advanced launch vehicle aimed at cutting cargo costs by an order of magnitude under those of the space shuttle, the author notes administrative go-ahead will probably not be forthcoming. Looks like the shuttle claims yet another victim.

"Biosphere for 10 Billion People Predicted"
L.A. Times, May 28, 1978
Reports Soviet astrophysicist Iosif Shklovsky's predictions of space colonies supporting 10 billion people within 250 years. He notes the necessity of employing extraterrestrial resources, a la O'Neill.

"Report On The National Scene/Let The SPS Shine Through", Patricia Jefferson
Astronautics & Aeronautics, May 1978
Interesting commentary on the politics of developing inexhaustible energy resources. The capricious and inane fumblings of ERDA, DOE, AEC, NASA and the OMB as they relate to SPS R&D are exposed. One such gem: while arguing that funding should be lowered for energy forms still awaiting demonstration of feasibility, DOE is pouring $460 million into nuclear fusion R&D in FY79. I can't help adding that fusion hasn't even demonstrated scientific breakeven, nor will it be anywhere near as clean (radioactively) as the DOE would have you believe.

Inside the L-5 Society

BOARD ELECTION RESULTS

The annual meeting was held 2 PM July 15th at the L-5 office in Tucson, as announced in the May **L-5 News**. Ballots were counted. Everyone on the ballot was elected. The votes for Directors are tabulated below:

Total ballots cast: 504

Asimov	487	Vajk	459
Hubbard	475	Kantrowitz	455
H.K. Henson	472	Parker	453
Goldwater	468	Weigle	452
Chapman	468	Finch	450
C.M. Henson	467	Smith	437
Woodcock	463	Hopkins	435
Dannenberg	461	Salmon	428
Heinlein	460	Huddle	417

Write-in votes

G.K. O'Neill	15	Timothy Leary	7
Gov. Jerry Brown	11	Jerry Pournelle	6
Arthur C. Clarke	10	Eric Drexler	5

Receiving three votes each were:

Ray Bradbury
T.A. Heppenheimer
Nichelle Nichols
Sen. William Proxmire
Rusty Schweikart
Rep. Olin Teague
Robert Anton Wilson

Receiving two votes each were:

Petr Beckman
Marc Boone
Ben Bova
Pete Conrad
Jacques-Yves Cousteau
Kurt Debus
John Denver
Buckminster Fuller
Sir Fred Hoyle
Hon. Barbara Jordan
Robert Lovell
Ken McCormick
Carol Motts
Larry Niven
Andrew F. Nimmo
Kerry O'Quinn
Jim Oberg
Thomas O. Paine
Ronald Reagan
Gene Roddenberry
Alan B. Shepard
Jesco von Puttkamer

Receiving one vote were:

Buzz Aldrin
Bill Angevine
Poul Anderson
Gary Barnhard
Christian O. Basler
Sen. Birch Bayh
Chesley Bonestell
Piet Bos
John W. Braue
Lillian Carter
Steve M. Cohn
Michael Collins
Doris Cooper
Philip K. Dick
James C. Fletcher
Rep. Ronnie Flippo
Gerald Ford
Harry Gray
Michael T. Harrell
Eleanor Helin
Gale Henson
John Holt
Richard D. Johnson
Lutz T. Kayser
Gerry Kitzman
Karl Konkel
Leo J.G. Little
Tom McCall
Paul McCready
George McGovern
Brian O'Leary
James W. Porter
Frank Press
Ayn Rand
Jon Ratner
Judy Resnik
Larry W. Roeder
Robert K. Rose
Roger Sansom
Conrad Schneiker
Allan Jay Silver
Gloria Steinem
A.E. Van Vogt
Paul Verbos
Sen. Harrison Williams
Rep. Larry Winn

We would like to welcome aboard new Directors Arthur Kantrowitz and Phillip Chapman, and thank past Directors Romualdas Sviedrys, Carol Motts, Dave Fradin, Leonard David and Magoroh Maruyama for their work for the Society.

Membership Drive

The current length and quality of the **L-5 News** is as much as we can afford to put out given the membership fees charged by L-5. (Please note that even putting out as much as we do we rely on writers contributing free articles, and on editing and layout being done for only $3/hour.) However, there is a way to greatly increase the content and quality and add color pictures to the **L-5 News**: we can carry advertising.

Alas, advertisers want lots of readers. The **L-5 News** circulation is only just barely topping 3,000 this month.

On the basis of the percentage of Tucsonans who have joined the Society, we can project a US membership of 45,000. A test bulk mailing to electrical engineers has to date resulted in over 2% joining the Society. Given the population of US electrical engineers as about 200,000, that's 4,000 potential L-5 members.

However, it is next to impossible to run ads and make direct mail appeals which can bring in enough money to both pay for the advertising and support the expenses of maintaining the new members. (Even given plenty of volunteer effort, supplying the **L-5 News** costs $14 per member per year.)

"For profit" magazines get off the ground by raising heaps of capital and running a deficit for many years before they build up circulation to the viable point. Non-profit organizations rely on donations and long term loans to accomplish the same thing. If you would like to see the L-5 Society's membership multiply ten fold in the next year, and the quality of the **L-5 News** increase correspondingly, please send in your donation earmarked "Membership Drive". If you wish to learn more about how it would be put to use, please let us know and we will discuss with you the direct mail and advertising proposals we are hoping to finance.

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NAME: ____________________

ADDRESS: ____________________

CITY/STATE/ZIP: ____________________

AFFILIATION/TITLE OR POSITION ____________________
(OPTIONAL)

I am____ am not ____ interested in being active locally. Phone (optional) ____________

____ Please enroll me as a member of L-5 Society ($20 per year regular, $15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of $12/year included in membership dues).

L-5 Society members who sign up for the Space Legislation Hot Line option receive frequent first class mailings on the actions of Congress and the President which affect the space shuttle, space colonies, solar power satellites, space exploration and other space projects.

____ Sign me up for the Space Legislation Hot Line.

MEDIA GROUP

by Howard Gluckman

Do you want to get a lot of interest in L-5 going in your area? Try science fiction conventions. Space Science Media Group, an organization set up by L-5 members John Sigwing, Steve Miszencin, and myself, did just that at Phantasmicon '78, May 26-29, at Los Angeles' Bonaventure Hotel.

With an exhibit room and several speaking times, we carried L-5's message to people with lots of interest but no way to direct it. We presented an L-5 panel discussion, two space colony slide shows, a search for extraterrestrial life show, and discussions of future possibilities from science fiction writer Dr. Jerry Pournelle and physicist J. Ray Dettling, both L-5 members.

For our exhibit room, we had displays on loan from Rockwell International, Jet Propulsion Laboratory, and the California Museum of Science and Industry. We also had literature for people to read, including some to take with them (and large stacks of L-5 applications).

Don't undertake something like this without help. Aiding us in many capacities were members Ralph Webster, B.J. Bjornen, Charles Carr, Alan Katz, Randy Reidel, Ru Emerson, Martin Rothblat, and Bob Manson.

Media Group exhibit at Phantasmicon

Letters

Congratulations to the L-5 Society and Carolyn Henson! Your article: "HR 1061: FOCUS OF CONTROVERSY" was printed just as I was in the process of composing one of the nastiest, poison pen letters ever written to the editors of **Mother Jones.**

One of the most incredible things about the article in **Mother Jones** is the ignorance required of a reader to believe this kind of criticism. For example, the point that they try to make about the solar power satellite being a "potentially lethal weapon" still makes me laugh when I think about it. Using a little common sense and knowing a few simple facts can punch holes in this argument in no time. A solar power satellite is large—several miles on a side—which was carefully emphasized in the **Mother Jones** article. How could one conceal such a satellite from detection? And since it (the SPS) was designed and constructed in weightless space, what kind of acceleration could such a satellite withstand? Certainly not much more than .01 G'S, if even that. Compare that with your average ABM missile, which can easily withstand 50 gravities of acceleration. Could an SPS hope to outrun a missile?

The point is this: any small country under attack could invest a few million dollars on a missile. Since an SPS is virtually impossible to defend (as I just demonstrated) it would be easy to destroy the SPS. So, for a few million you could destroy a satellite worth billions and which would also be a major power supply for the enemy. Any military strategist could tell you that the SPS is not a weapon.

Along with faulty reasoning, Mr. Hochschild (the author) makes many statements which are simply lies. And he also makes the assumption that all the SPSs would be launched from the ground, and he ignores the Space Colony alternative. This is most unfair of him because he does know about the work of Gerard O'Neill and he proves it by mentioning Mr. O'Neill's name. The most unkind cut of all comes when he makes a vague reference to "some O'Neillians who want to bomb the moon." (nuclear mining technology.) The use of the word "bomb" shows what simple propaganda this is. It was the likes of Mr. Hochschild who were behind the Nazi propaganda machine in WW2.

I regret having to end this letter by condescending to the level of the editors of **Mother Jones** and by encouraging others to do the same, but it appears that the use of one of **MJ's** recommended policies is in order. It appears that a boycott of **MJ** magazine is required to stem the flow of such malicious ignorance.

Matthew Swass
South Orange, NJ

In all fairness to Mr. Hochschild, it should be pointed out that he was referring to Kraft Ehricke's proposal to mine the moon using nuclear bombs. For an analysis of the shortcomings of his proposal see "Nuclear Mining", June 1976 **L-5 News**—*CH*

Your readers may be interested in a new free "mini-magazine for educators", **Air & Space**, published by the Smithsonian Institution. A subscription may be obtained by writing the National Air and Space Museum, Room 3569, The Smithsonian Institution, Washington, D.C. 20560.

Jay S. Huebner
Jacksonville, FL

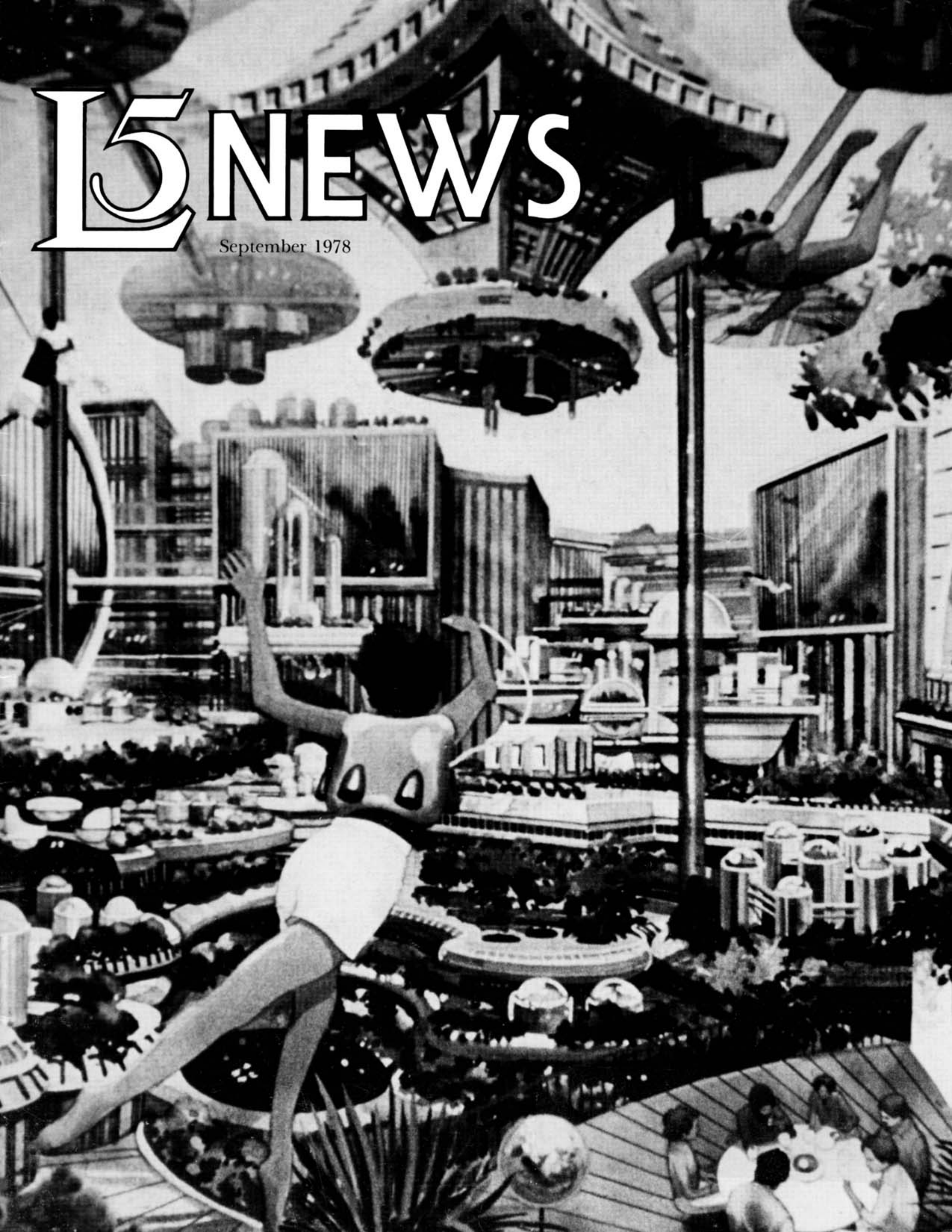
Where did NASA administrator Frosch get a $500 billion figure for SPS? I thought NASA's own studies had it pegged in the $50-200 billion range. Was this a deliberate attempt to scare the Senators present (at the Future Space Program hearings)?

Michael C. Strong
Swartz Creek, MI

Our NASA sources insist that no study on SPS has come anywhere near Frosch's $500 billion estimate. Apparently he came up with it on his own — CH.

L5 NEWS

September 1978



L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY
VOL. 3 NUMBER 9 SEPTEMBER 1978

In this issue:

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Linda Salisbury

William Weigle,
Administrative Services

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1 **SPS Hearings** *Ken McCormick reports.*

3 **LDEF Input**

4 **Energy and Alternative Futures** *Solar power satellite researcher Gordon Woodcock explores some of the implications of "soft" vs. "hard" technology.*

5 **L-5 Society Slide Show**

14 **FASST to Study Student Input on SPS**

15 **Inside the L-5 Society**

18 **Letters**

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L-5 Society
Membership Services
1620 N. Park
Tucson, AZ 85719

Cover: A zero-g space habitat *(courtesy Ames Research Center).*

SPS Hearings

by Ken McCormick

"SPS would be enormously expensive. . . with program costs estimated at $1.5 trillion by the turn of the century. . . . When cost overruns are included, we may well be stuck with an enormous investment in an uneconomical project — a Vietnam of the sky." — Sen. James Abourezk

"To say that the SPS program will cost trillions of dollars is unfounded, unfair, misleading, and downright ludicrous." — Rep. Ronnie Flippo.

On August 14, the Senate Subcommittee on Energy Research and Development held hearings on S. 2860. It is the Senate equivalent of H.R. 12505, which was introduced into Congress last January by Representative Ronnie G. Flippo of Alabama. The program called for by these solar power satellite (SPS) bills would supersede the current DOE/NASA "SPS Development and Concept Evaluation Program", and increase funding for SPS to $25 million for fiscal year 1979.

Subcommittee member Sen. James Abourezk (D-SD) opened the hearings with an anti-SPS broadside: "With respect to S. 2860 . . . I'd like to say that I've long been a supporter of solar energy, and sponsored a great deal of legislation to encourage its use. Nonetheless, the harnessing of the sun through the deployment of the solar power satellite seems to me to be a singularly ill-advised and wasteful approach. Solar power satellites would be enormously expensive, and the money that would be spent on their development would be much more efficiently spent on developing smaller scale or more diversified solar approaches. With total program costs estimated at $1.5 trillion by the turn of the century, I fear that this bill will only serve to further concentrate economic and consequently, political power in the hands of a few corporate giants, while freezing out the innovative smaller businesses, who could, with much less public money, provide this country with a truly solar economy.

"Moreover, solar power satellites present enormous environmental hazards in the form of microwave radiation, a subject we are only beginning to understand. It also raises serious military questions with which we simply do not have the institutions to deal. Frankly, I fear that this bill sets the stage for a boondoggle of unprecedented proportions, that will be of benefit only to the aerospace industry . . . This kind of wasteful, uninformed government spending, largely at the behest of industry, is hardly consistent with the mood of the taxpayer or the fiscal needs of the country.

"Presumably, proponents of 2860 assume that there is already enough information to go on to development and demonstration. Studies have been cited that ultimate costs per kilowatt-hour will be no more than those for power generated by nuclear plants. These same studies, however, are based on such contradictory and speculative assumptions that we can hardly use them as the basis for a commitment as large as this bill contemplates. To give but one example, the capital costs of the receiving antenna were estimated at 17% by project proponent Peter Glaser, 42% by the Johnson Space Center, and 8% by the Marshall Space Center.

"We also do not know enough about the effects of microwaves, which have been shown to cause central nervous system problems, cataracts and genetic changes, and possibly are carcinogenic and involved in sudden infant death.

"The ongoing Department of Energy/NASA study addresses such cost and environmental problems as these. I see no reason to proceed until we have the answers that study will provide.

"Even if it does turn out that there is some potential, here, I think that there is more to fear if the solar power satellite succeeds than if it fails. The promoters of the solar power satellite have formed a group called 'Sunsat' to push the idea. Sunsat's major members are General Electric, McDonnell Douglas, Grumman, Boeing, RCA, Westinghouse, Lockheed and Martin Marietta, plus various engineering firms and public utilities. If we go ahead and spend hundreds of billions or even trillions of dollars on this project, we will be creating a massive energy complex controlled by these industrial giants . . . Massive government regulation would be necessary to protect the consumer.

"Moreover, as the system is being developed, it will, I fear, freeze out more responsible solar development.

"Proponents argue that this bill only commits $25 million, and less than $200 million will be spent over the next five years. Boeing, however, is proposing a minimum of 3 billion over the next five years as the amount needed to proceed to development by the turn of the century.

"Whatever the amount, I think we should be guided by the familiar and apt aphorism that 'In Washington, projects have only two stages—too early to tell, and too late to do anything about.' As appropriations for this project mount, year after year, it will be harder and harder to forsake the previous accumulated expenditures, even if we find that the project is no longer as practical as it seemed.

"Cost projections now state that full research and development will cost 40 to 80 billion dollars, with each satellite to cost 25 billion dollars. These estimates are from the aerospace industry which is notorious for underestimating costs.

"Nonetheless, even at these optimistic projections, the cost per kilowatt-hour is expected to compare only to nuclear costs. When cost overruns are included, we may well be stuck with an enormous investment in an uneconomical project—a Vietnam of the sky."

Representative Flippo was soon on the witness stand with a rebuttal to Abourezk's attack: "The SPS concept has been under consideration for ten years . . . Despite all the evidence amassed in support of this program, it has been treated in the past with benign neglect by responsible agencies. They say the SPS program is needed and shows great promise, but request little or no funding for it, which in turn stifles development.

"At the present time, the Department of Energy and NASA are conducting a joint three-year SPS study. Their objective is to develop an understanding of the technical requirements, economic practicality, and social and environmental acceptability of the SPS concept . . . .

"The DOE/NASA program is a good start. However, the program only entails an expenditure of 15.6 million dollars over the three year period. These funds will provide for paper studies which will focus on systems definitions, environmental issues, and economic considerations. These are issues that have been under study for the past ten years.

"Testimony presented during hearings in the House have confirmed that the technical, environmental, economic, and other related issues cannot be resolved without an adequate technology verification program . . . .

"Senate Bill 2860 will complement the existing program by providing for the necessary technical verification program. It would strengthen the existing program by bridging the gap between paper studies and hardware verification.

"Sometime in 1980, DOE and NASA will be making a decision to continue or stop the SPS program. Congress, in turn, will have to confirm or reverse this decision. This responsibility suggests that Congress would be prudent to begin now to thoroughly examine the technical, economic, and environmental issues, and to generate the experimental issues and the experimental data necessary to make a sound go-no-go decision on the SPS program . . . .

"The SPS concept holds great promise as a viable long-run energy source. Yet when placed in the context of the other long-run non-depletable baseload energy options, solar power satellite research is being short-changed. Fusion research receives Congressional support of more than 400 million dollars per year; nuclear fission receives more than one billion dollars per year. We need to pursue all these energy options, and each option should be given a balanced examination commensurate with its potential.

"In the course of the House hearings a number of criticisms were leveled against the bill. For the most part, the objections to the bill were valid and legitimate, representing some of the same questions in my mind when I first explored this concept. These objections and criticisms were very much in mind when witnesses were developed for the House hearings on the SPS legislation.

Rep. Ronnie Flippo, originator of the SPS bill, testifying at the Senate hearings. (Photo courtesy Charles Divine.)

"In view of the testimony presented in these hearings, the content of the House report of H.R. 95-1120, and the considerable publicity provided by the bill, I believe the objections have been laid to rest. In case they have not, I would like to review some of the major criticisms.

"First of all, the cost. Criticisms of the SPS bill on the basis of cost have been most perplexing. To say that the SPS program will cost trillions of dollars is unfounded, unfair, misleading, and downright ludicrous. To say that the legislation under consideration here today will authorize a multibillion-dollar space program is untrue and irresponsible. Senate Bill 2860 does not provide for or authorize a multibillion dollar space program. The bill does not commit the nation or the Congress to commercial-sized satellites . . . .

"Initially, the Space Shuttle would serve as the development vehicle. There is no requirement that we develop heavy-lift launch vehicles at this time, or an orbital construction base, or solar cell production facilities . . . The SPS is generally viewed as an incrementally funded program taking approximately 15 years to fully implement.

"In regard to the environmental concerns, the bill does not attempt to hide, disguise, ignore or minimize the environmental issues associated with the SPS concept. On the contrary, the members of the House subcommittee on energy and space programs made every possible effort to identify and assess the environmental issues.

"Distinguished scientists from academic institutions and private research laboratories and federal agencies were invited to particpate in hearings on this bill held this year. These learned scientists clearly identified all the environmental issues associated with the SPS concept for the members of the subcommittees. They provided information about the status of ongoing research efforts to analyze and solve these environmental questions, and they outlined research programs that would seek to resolve these enivronmental issues by a combination of analysis, systems studies, and experiments on Earth and in space. For those who want to know more about the committee approach, I would recommend a careful reading of the committee report of H.R. 12505." (For a copy, write to Science and Technology Committee, U.S. House of Representatives, Washington, DC 20515.)

"In addition to thoroughly reviewing the environmental issues, the report contains what I believe to be an innovative, unique approach to addressing the environmental concerns. The report recommends the establishment, within the overall SPS program plan, of a mechanism that will allow for independent review and consultation on the environmental, biological, and ecological issues. This

Left to right: James J. Kramer, John Deutsch and Fred Koomanoff, testifying in opposition to the bill. (Photo courtesy Charles Divine.)

independent review mechanism would isolate the environmental judgements from the program management, and from the program proponents.

"Based on currently available data, adverse environmental effects are not anticipated because of the relatively low level of transmitted microwave energy being considered. The SPS can be designed to operate effectively and efficiently within the existing microwave exposure standards in this country and elsewhere. However, all possible effects of microwave transmission must be reevaluated in the context of the SPS design to resolve outstanding environmental questions.

"Additional research is certainly necessary, and this is the purpose of the SPS legislative program. If effects are discovered, the SPS system design can probably be modified to alleviate the effects. If the appropriate design changes cannot be made, then we will have to pursue other energy alternatives.

"The environmental research initiative provided in S. 2860 will supplement and complement existing research efforts to assess the biological effects of this radiation. At the present time, the federal government is spending approximately 9.3 million on this form of research.

"The research and development of the SPS will require an increase. . . The SPS legislation may be the driving force in solving the mysteries of microwave radiation."

Mr. Flippo agreed that it is worthwhile to invest in the development of decentralized solar power, but added that SPS would be a "complete solution that will turn the engines of society," and would "place a cap on energy costs."

Senator Floyd Haskell of Colorado questioned Mr. Flippo on the SPS program: "It is my understanding. . . that both DOE and NASA are already making feasibility studies to answer some of the questions that you've raised. If that is the case,. . . what does this bill do that the feasibility study wouldn't do?"

"The main thing that it would do would (be to) move us into a technology verification phase. The status of DOE/NASA activities were confined primarily to paper studies prior to the introduction of this bill. We cannot base a program. . . on paper studies or surveying current literature, alone. We must prove the foundations or the assumptions on which these paper studies have been based, and that's what this bill intends to do. . ."

DOE and NASA spokesmen appeared before the subcommittee to reiterate the position that the current SPS evaluation program is sufficient. In the words of DOE Energy Research director, John M. Deutch: "Based upon our present knowledge and understanding of the SPS systems concept, we feel that it is premature to proceed with any orbital demonstration or SPS hardware systems development. We, therefore, recommend against the Senate Bill #2860 being considered by your subcommittee."

Senator Haskell questioned Dr. Deutch about the cost of SPS: "The figures that are available to me - I'd like to know how accurate they are - (indicate) that one of these satellites might cost $25 billion."

Dr. Deutch replied: "I would guess that with the first satellite—that might be true. I wouldn't come back to you on a precise number, there."

In response to questioning by Sen. Melcher, Dr. Deutch explained that $3.4 million is now budgeted for the SPS evaluation in the fiscal year 1980, but that he regarded that amount of money to be insufficient to carry out research activity which will take place at that time. Under strong pressure from Senators Haskell and Melcher, Dr. Deutch revealed that he thought he might request that the budget be increased to somewhere in the neighborhood of $8 million for FY 1980.

(Continued next month.)

LDEF Input

The NASA Office of Aeronautics and Space Technology (OAST) is actively planning future utilization of the Space Transportation System for technology and other experiments in space. The development of the Long Duration Exposure Facility (LDEF) and the development of experiments for the first LDEF mission to be flown in early 1980 are a part of the OAST approved shuttle utilization plans.

The initial LDEF is a reusable, shuttle-transported, free-flying carrier for recoverable experiments requiring a 6- to 12-month stay in space. In the solicitation of experiments for the first LDEF mission, many respondents also indentified a need for LDEF-type missions of 5 years' duration or longer. The facility required for such a mission may be significantly different from the initial LDEF. Accordingly,, the OAST has approved a study to further investigate the needs and specific requirements for an extended-duration LDEF-type mission and to develop the facility and mission concept.

If you would like to have input in LDEF planning, address responses and/or questions to:

Dr. C. Howard Robins, Jr.
Manager, LDEF Program
Code RS-7
NASA Headquarters
Washington, DC 20546

Telephone: Area code 202/755-8504

Energy and Alternative Futures

by Gordon R. Woodcock

When I was a boy of ten, growing up in a small town in Oregon, the people I knew didn't think about the future very much. When they did, it was mostly about returning to normalcy after the war was over. Any speculation about future novelties I had seen or heard dealt mostly with the idea of a private plane in everyone's garage. But hidden things were happening in 1943. In secret cities in the United States, fever-pitch work was going on, to transform the recent discovery of uranium fission into a war weapon of unheard-of destructiveness. In Germany, the research laboratories at Peenemunde were making equally amazing progress in the adaptation of a curious "toy," the liquid-propellant rocket, to the modern military purpose of long-range bombardment. Under the pressures of the war efforts, the tempo of technological progress was highly accelerated. Humanity emerged from the crucible of World War II with the essentials of a technology capable of the destruction of civilization, if not of all life on Earth, and also capable of approaching the frontiers of space. "Normalcy" has neither been seen nor heard of since.

Until 1938 the energies of the atom's nucleus were believed by scientists to be forever beyond the reach of mankind. Experiments bombarding uranium with neutrons were conducted as early as 1934, but the idea that a nucleus could fission, permitting a chain reaction to release the powerful nuclear force, was thought contrary to physical law. The accumulation of evidence finally overcame preconceived notions, and the discovery of fission was quickly followed by recognition of the possibility of a self-sustaining chain reaction. The race to harness nuclear power was on.

Almost since the beginnings of nuclear energy research, there has been controversy over what could, should, or would be done with the nuclear genie released from the bottle of science and technology. Along with pessimism and concern about nuclear weapons, there has been a great deal of optimism regarding the benefits of nuclear energy for the future of mankind.

Ordinary fuels derive energy from the electromagnetic force that binds atoms together into molecules. Nuclear fuels release the nuclear force that binds atomic nuclei together, a force that is millions of times more energetic than electromagnetic forces; nuclear fuels are consumed only very slowly while releasing great amounts of energy. Because of this, it was once believed (at least by some physicists) that electricity produced by nuclear reactors would someday be so cheap that power meters would be unnecessary.

Only much later did the realities of nuclear power emerge. Fission fuels are scarce elements; even their prodigious ability to produce energy does not remove them from the list of finite resources. Nuclear electricity is not unimaginably cheap, although it is today cheaper than fossil-fuel-generated electricity. Fears about the drawbacks of nuclear power, notably its radioactive wastes and the relationships between reactors and weapons, have spawned an occasionally irrational and highly vocal anti-nuclear "movement." The objective of this movement is to reverse the now perceptible beginnings of a world transition in energy sources, a transition from oil to nuclear power.

In general, the anti-nuclear movement offers no comparable alternative, apparently believing that its case against nuclear power is so strong that no comparable alternative need be offered. A non-comparable alternative is frequently offered: "soft technology," or make do with less. (The public, based on polls and on results of votes on anti-nuclear initiatives in several states, seems unconvinced by this movement.) The roots of the soft technology philosophy run far deeper than just an anti-nuclear movement.[1] Its proponents think of it as a new economics, and often as a new social order. They do not, at least in any of the literature I have read, [e.g. 3,4] offer any quantitative economics analyses to support their philosophy. (In my view, basing an economic system solely on philosophical arguments is like trying to balance your checkbook without doing arithmetic.) The origins of this philosophy can be found in energy issues.

In previous articles we noted that there are several viewpoints on energy supplies, and that questions on energy policy are thoroughly entangled with the business of economics. Despite widespread discussion of the so-called energy crisis, there is still a belief in many quarters that if left alone, the energy situation will take care of itself. This viewpoint generally argues that if the government would stop regulating energy prices, market economics would provide adequate supplies for everyone.

It is indeed reasonable to presume that market economics would strike a balance between supply and demand, but with a finite and diminishing resource, the characteristics of market economics could easily result in a crisis situation with timescales short by comparison to the time required to develop alternative energy solutions. The finite resource economics model displayed in the prior article, [June L-5 News] although simple and primarily illustrative, suggested that in the early phases of finite resource economics, under the law of supply and demand, the consumption rate appears to follow exponential growth with relatively little signal that anything is fundamentally wrong except for persistent increases in price. Later, as supplies continue to diminish, rapidly escalating prices cause a turndown in consumption, presumably accompanied by severe economic dislocations.

In 1973, even before the widespread recognition of the energy crisis, Klaus Heiss described the results of a study of resources in the Congress [5] "In a recent report on various forecasting techniques and in the analysis presented in this section, we could not find any single material resource which decisively influences the economic and military power

(Continued page 13)

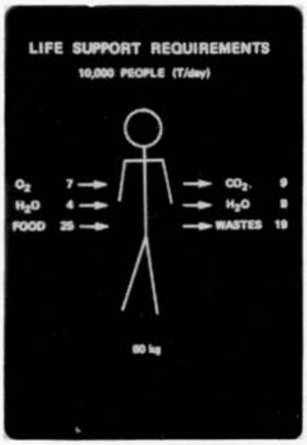
L5 SOCIETY SLIDE SHOW

Space Stations

A01 A modular space station. Each module is carried up by the space shuttle.

A02 An apartment inside a shuttle main tank which has been converted to a space station.

Life Support



LIFE SUPPORT REQUIREMENTS

10,000 PEOPLE (T/day)

O_2 7 → → CO_2 9

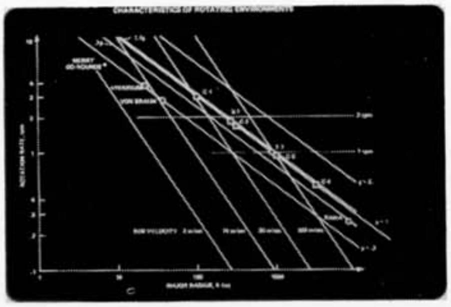
H_2O 4 → → H_2O 8

FOOD 25 → → WASTES 19

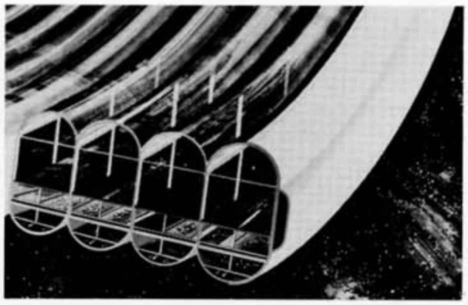
80 kg

A11 Life support requirements, taken from the Stanford Torus study.

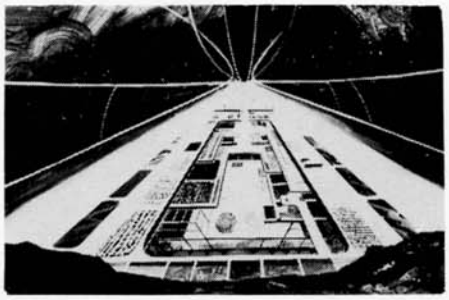
Space Habitats



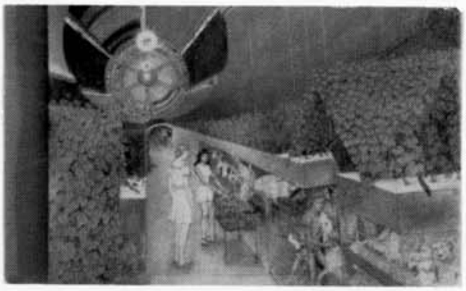
A12 Design considerations for rotating space habitats.



A13 Agricultural area of a Bernal Sphere habitat.

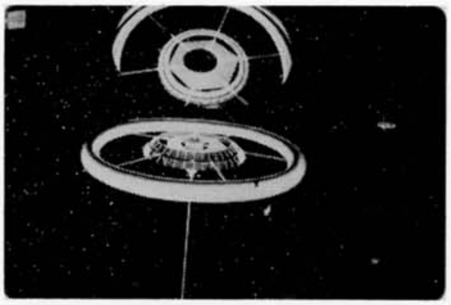


A14 Agricultural area of the Stanford Torus

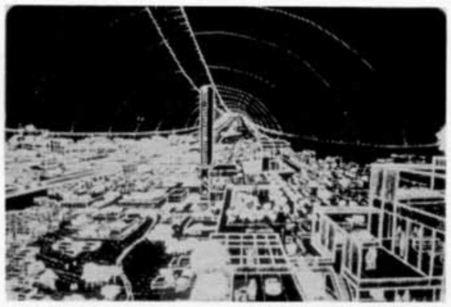


A15 "Construction shack" habitat space farm.

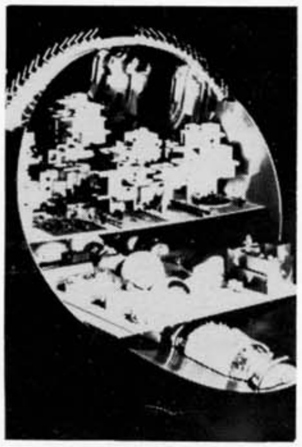
Stanford Torus



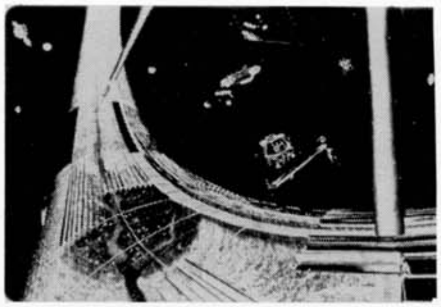
A21 A completed colony (toroid design by 1975 NASA/Ames Summer Study).



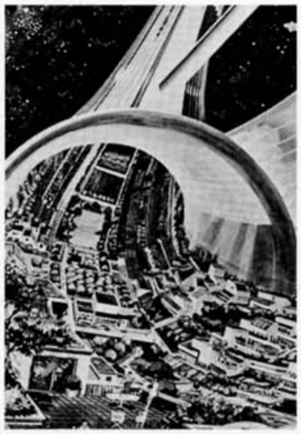
A22 Interior of a colony (toroid design by 1975 NASA/Ames Summer Study).



A23 Cross-section of a model of the Stanford Torus, showing habitat, and other areas.

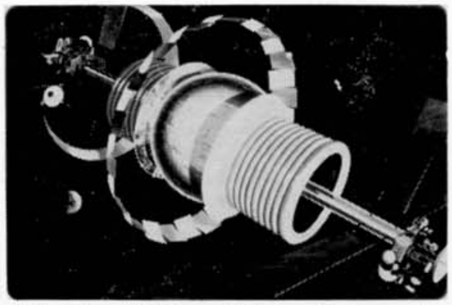


A24 Construction in space of a space colony (toroid design).

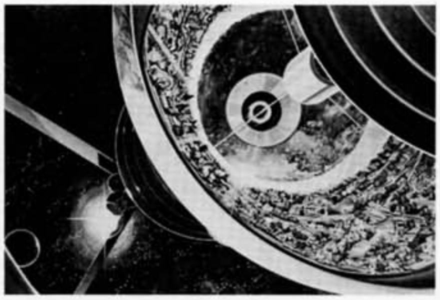


A25 A village in the Stanford Torus.

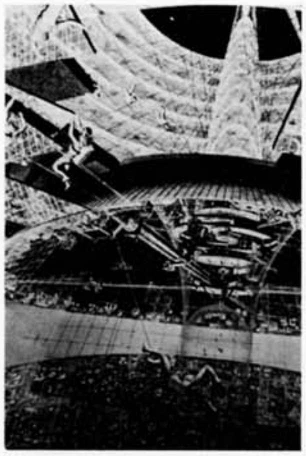
Bernal Sphere



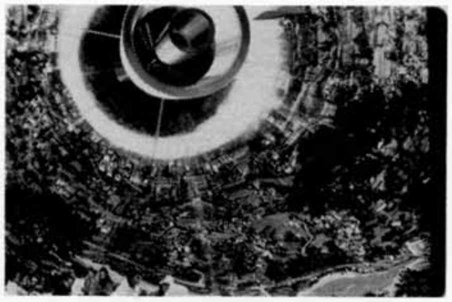
A31 "Bernal Sphere" design for an early space habitat—accommodating about 10,000 people.



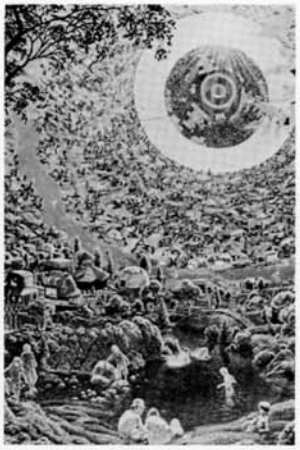
A32 A view through the window area of the Bernal Sphere.



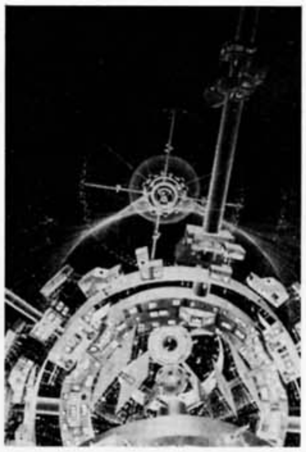
A33 Construction of the Bernal Sphere.



A34 Interior of a "Bernal Sphere" space colony.

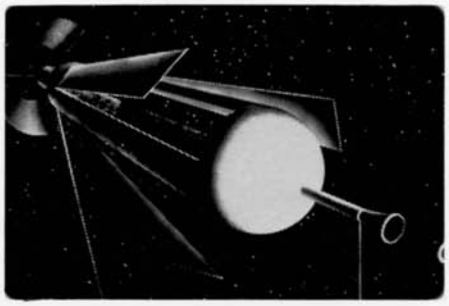


A35 A 1 gravity recreation area.

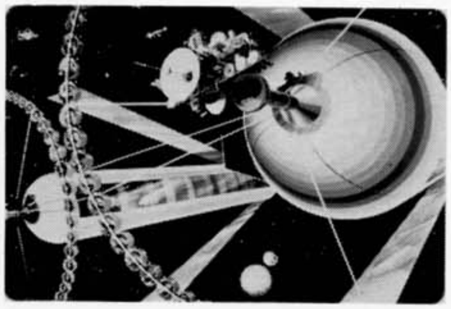


A36 The zero gravity recreation areas at the Bernal Sphere hubs at night

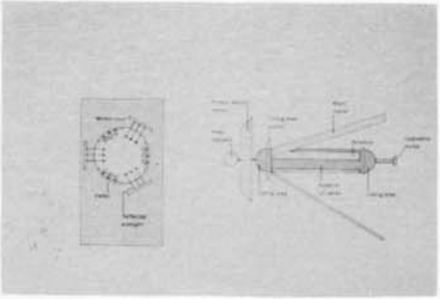
O'Neill Cylinder



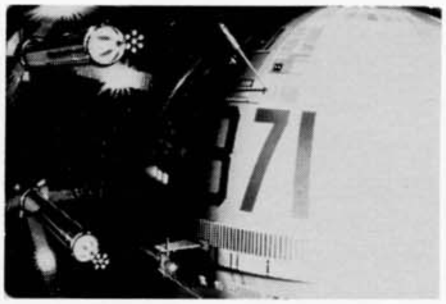
A41 First painting of a space habitat—four by twenty miles in size (cover of *Physics Today,* September 1974).



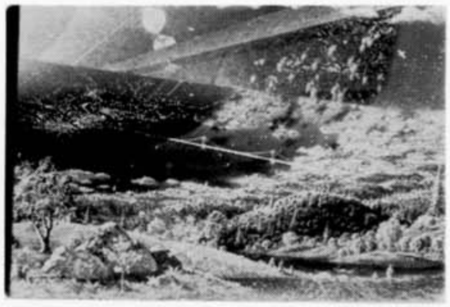
A42 An advanced colony. Two cylinders in tandem, each with a four mile diameter and twenty mile length.



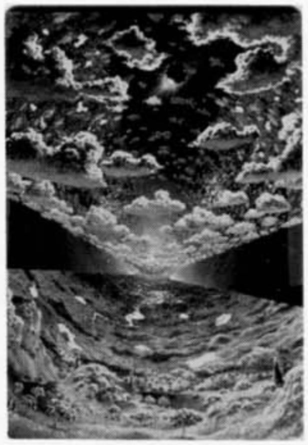
A43 Diagram of Model 1 space habitat indicating living areas, valleys, and energy source.



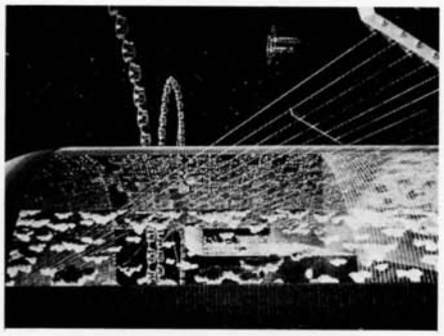
A44 The spaceliner *Robert H. Goddard* brings in a new group of immigrants (Courtesy *Science Year*).



A45 Interior design of a colony founded by a group of expatriate San Franciscans.



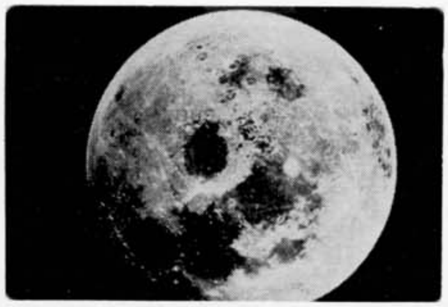
A46 Solar eclipse in a colony. Cylinder interior is viewed along its axis.



A47 A side view of the O'Neill cylinders.

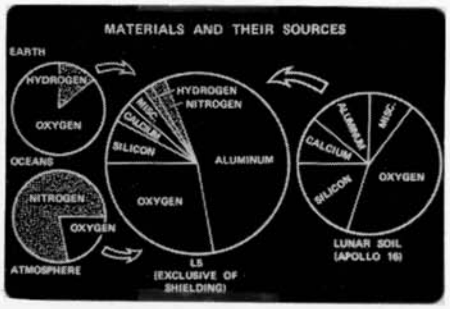
A51 A zero gravity habitat.

Extraterrestrial Resources



B01 The Moon, source of most of the materials for space colonization.

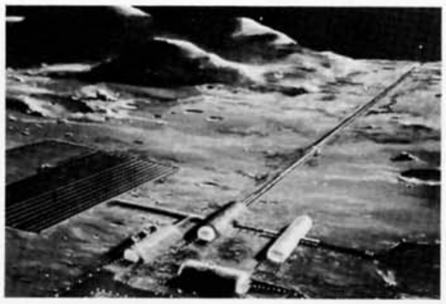
B02 Apollo 8 view of the Earth seen from the Moon (NASA photo).



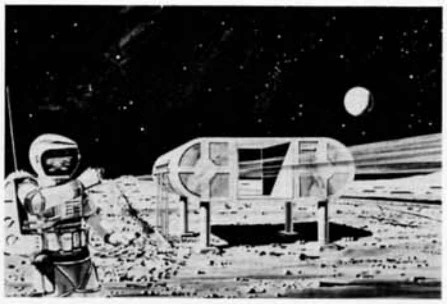
MATERIALS AND THEIR SOURCES

B03 Summer study slide showing that almost all of the materials can come from the Moon.

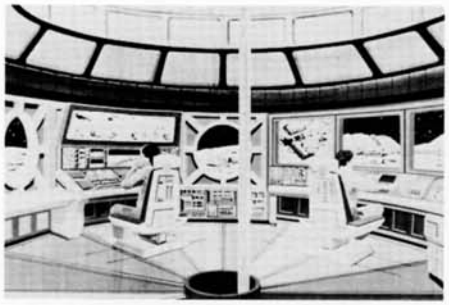
B04 Lunar mine to obtain materials for construction in space (Field Enterprises).



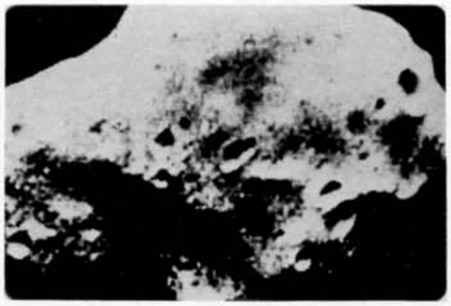
B05 The lunar mass driver.



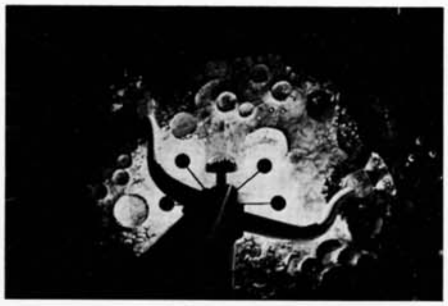
B06 A closeup of the end of the lunar mass driver, where ore is being shot into an escape trajectory.



B07 Control center for the lunar mining base.



B11 Phobos—asteroids are believed to look like this.

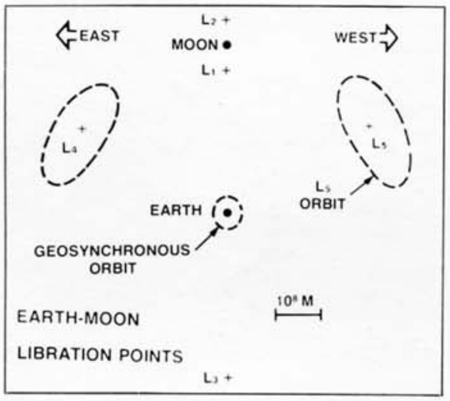


B12 An asteroid mining operation.

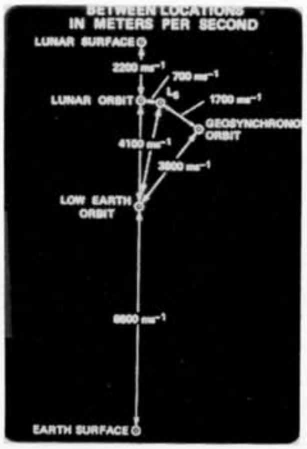
Space Transportation

C00 A century's progress in transportation.

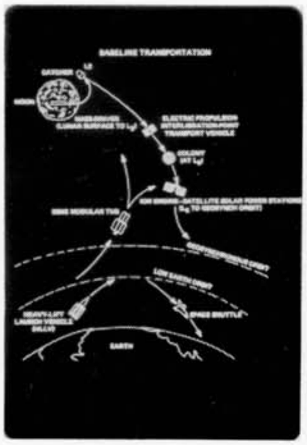
Orbits and Orbital Transfers



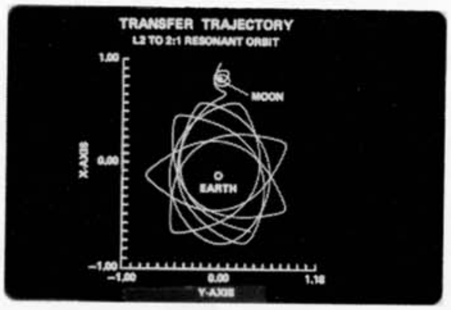
C01 Lagrangian libration points.



C02 Distance between significant points in meters per second.


BASELINE TRANSPORTATION
CATCHER
L2
MOON
MASS-DRIVER (LUNAR SURFACE TO L2)
ELECTRIC PROPULSION INTERLIBRATION-POINT TRANSPORT VEHICLE
COLONY (AT L5)
ION ENGINE—SATELLITE SOLAR POWER STATIONS (L5 TO GEOSYNCH ORBIT)
GEOSYNCHRONOUS ORBIT
LOW EARTH ORBIT
HEAVY-LIFT LAUNCH VEHICLE (HLLV)
SPACE SHUTTLE
EARTH

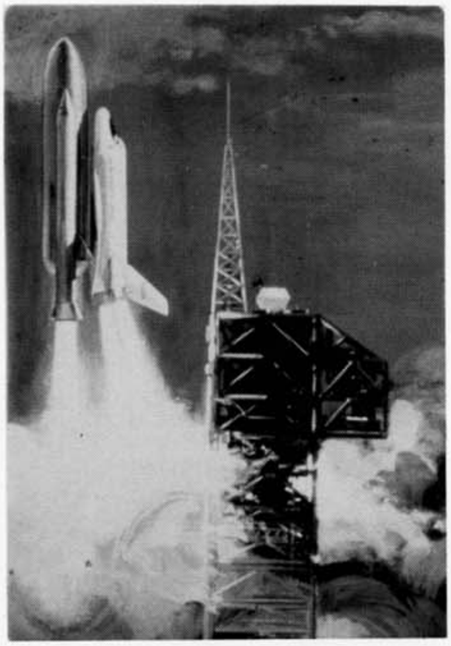
C03 Baseline transportation diagram: Earth, Moon, colony at L-5.



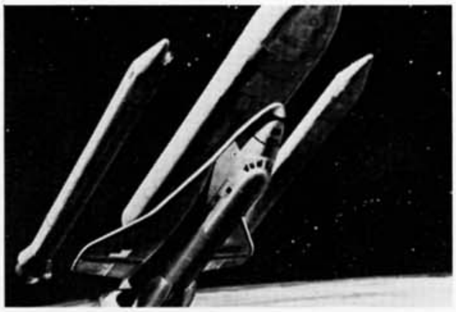
C04 Transfer trajectory from L-2 to 2:1 resonant orbit.

Space Shuttle

C10



C11 Takeoff.

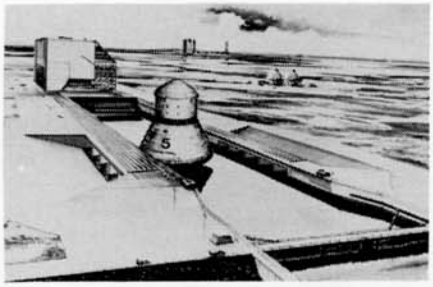


C12 The reusable solid fuel boosters separating from the orbiter. They will fall into the ocean, suspended from parachutes. The main fuel tank, still attached, will be discarded later, either to burn up as it falls to Earth, or to be kept in orbit for use in space station construction.

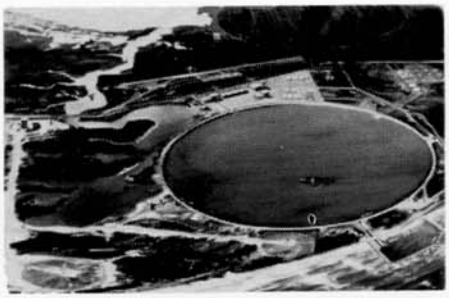
C13 Shuttle orbiter reentering the atmosphere.

C14 Orbiter landing at Vandenberg AFB.

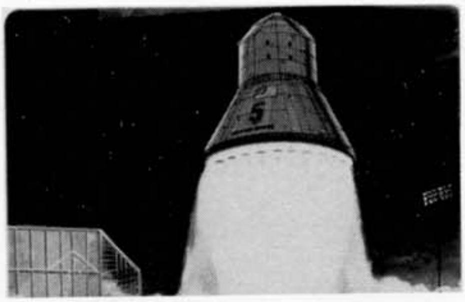
Heavy Lift Launch Vehicles



C31 Heavy lift rocket docked and ready for next trip to construction site (Boeing).

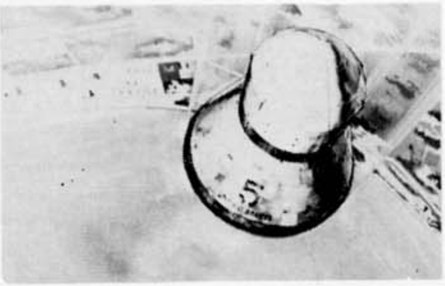


C32 Cape Canaveral in the future, with landing basin and power receiving antenna (Boeing).

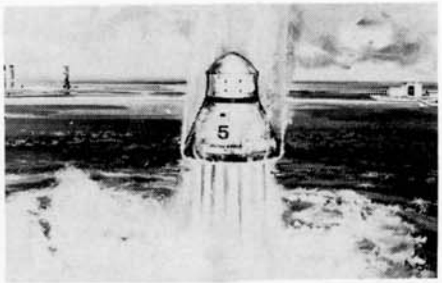


C33 Heavy lift rocket takes Earth materials for construction to satellite solar power station (Boeing).

C34 A slightly different heavy lift vehicle just after the lower stage has separated. (Boeing)

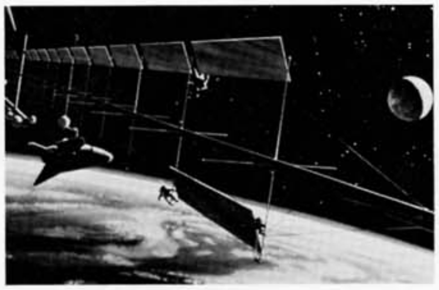


C35 Heavy lift rocket re-entering and heading for landing basin (Boeing).



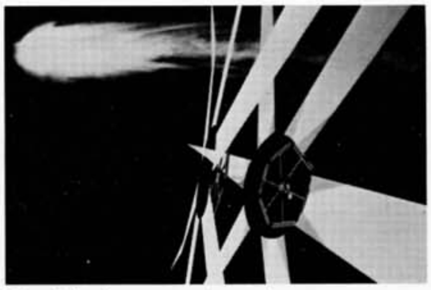
C36 Heavy lift rocket landing after delivering Earth materials to construction site (Boeing).

Advanced Propulsion

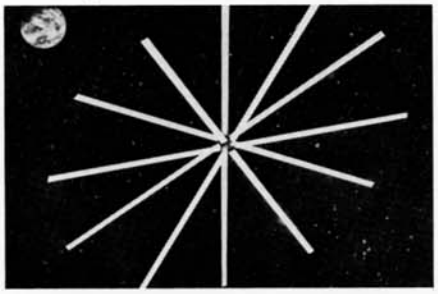


C41 Shuttle orbiter docking with a transport linear accelerator (TLA) which is under construction. The TLA uses a solar powered linear electric motor to throw mass out the end, which propels it forward. It is very similar to the lunar mass driver.

C42 A TLA carrying a load of lunar ore to a space processing facility.



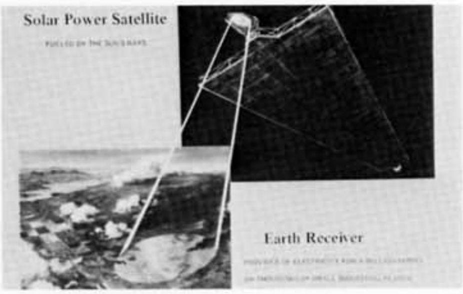
C43 A heliogyro solar sail approaches a comet. It is propelled by the thrust given when light bounces off its sails. Rotation stiffens the sails.



C44 Another view of the heliogyro.

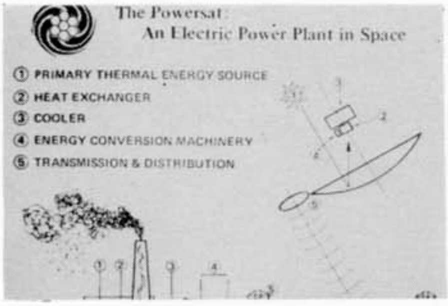
Solar Power Satellites

SPS Concept

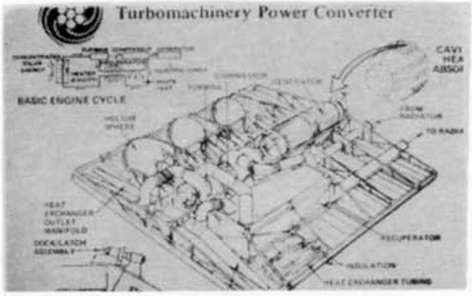


D01

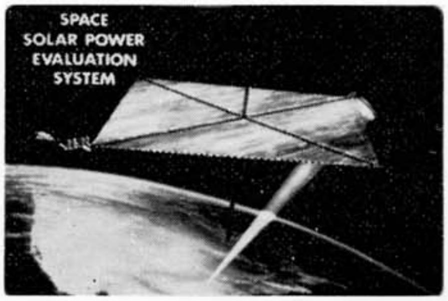
D02 A view of the Middle East, present focus of energy discussions.


The Powersat:
An Electric Power Plant in Space
① PRIMARY THERMAL ENERGY SOURCE
② HEAT EXCHANGER
③ COOLER
④ ENERGY CONVERSION MACHINERY
⑤ TRANSMISSION & DISTRIBUTION

D03 The Powersat: An Electric Power Plant in Space (Boeing design).

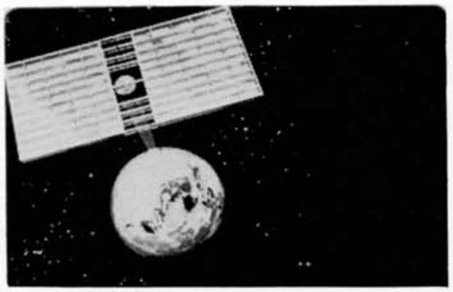


D04 Design for Turbomachinery Power Converter.

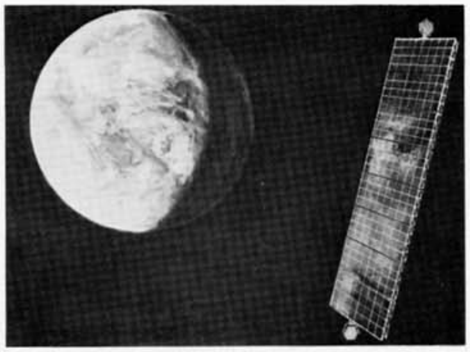


D05 A small SPS demonstration model necessary to test the concept.

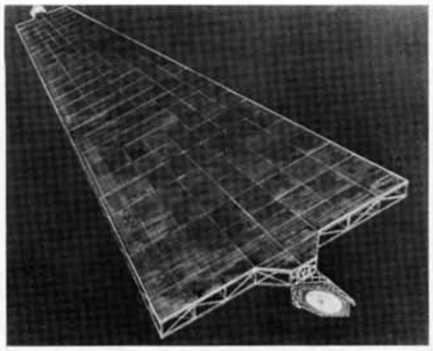
The Space Collector



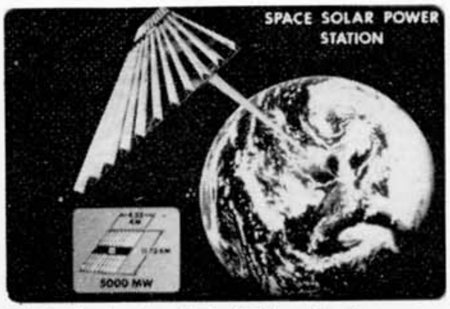
D11 Power satellite of the photovoltaic type (Arthur D. Little).



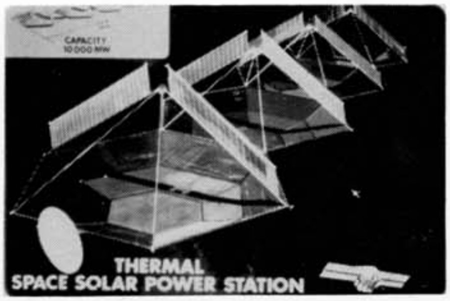
D12 Another photovoltaic SPS. The hexagons at the ends are microwave transmitters.



D13 Another view of the SPS.

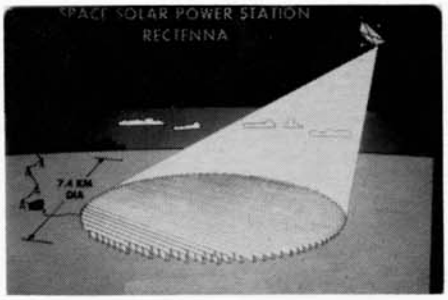


D14 A photovoltaic SPS, with the dimensions shown.


CAPACITY 10 000 MW
THERMAL SPACE SOLAR POWER STATION

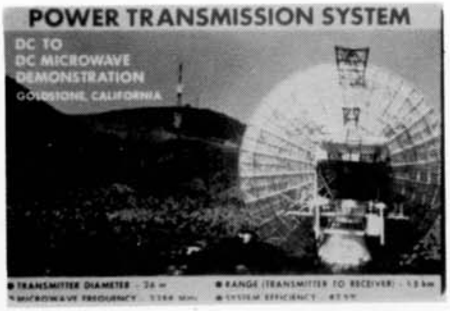
D15 A thermal SPS.

Power Transmission

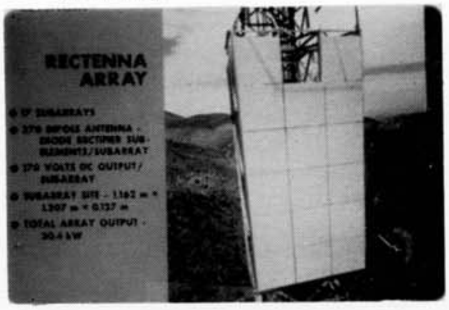


D21 The SPS beams energy via microwaves to an Earth rectifying antenna farm where it is converted to DC electricity.

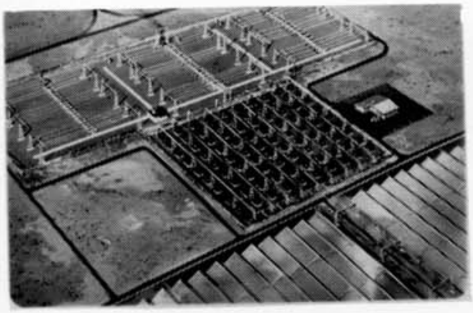
D22 Rectenna array over farmland for receiving microwave transmission from SPS.



D23 Microwave power transmission test (summer of 1975).

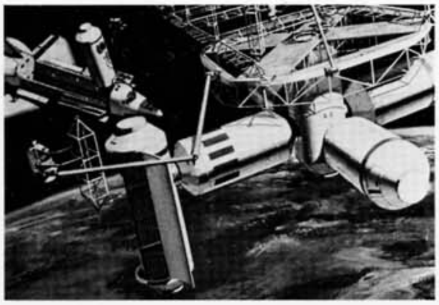


D24 Microwave power transmission test (summer of 1975).

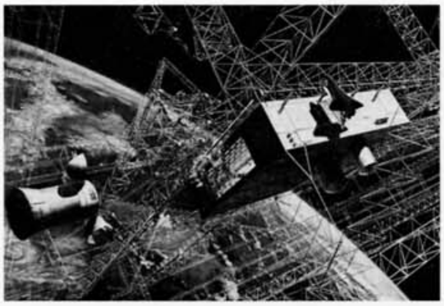


D25 Inverters and standard power grid at the edge of the rectenna array over farmland.

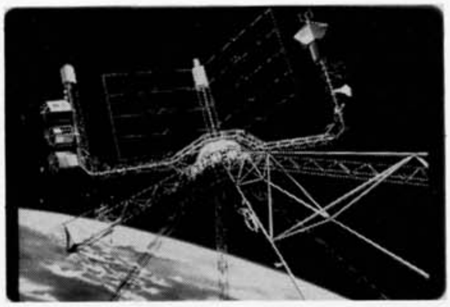
SPS Construction



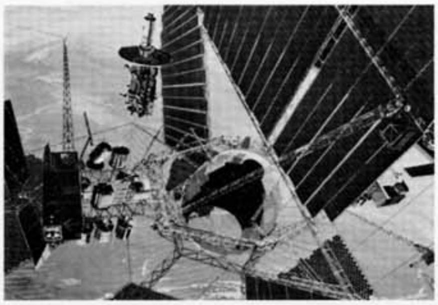
D31 Shuttle orbiter is docking at the SPS construction workers' living facility. (Rockwell)



D32 A large hangar where construction workers are bulding SPS components. The heavy lift launch vehicle brings up materials; the shuttle orbiter carries workers. (Boeing)



D33 The heat cavity of a thermal SPS. (Boeing)



D34 The heat cavity under construction. (Boeing)

Spread the News

Your local schools, churches, civic groups and clubs are looking for lecturers. As an L-5 member, you can probably fill the bill. Are your nervous in front of an audience? Try your lecture on some friends in your living room. Move on to scout troops and grade school classes, and before you know it you'll be regaling the Rotary Club and appearing on your local TV show without flinching. Developing public presence is only part of the job. You must be knowledgeable, accurate, able to present complex ideas in a clear and straight forward manner, and entertaining (or at least undull). In dealing with questions, be willing (if necessary) to admit that you don't know the answer. Treat your critics with respect, even if they don't respond in kind.

Getting Speaking Engagements

How do you get invited to speak? To get started lecturing to schools and scout troops, begin with your children or friends' children—they'll introduce you to teachers and group leaders. If you are a church-going type, your minister can introduce you to the people who schedule entertainment at church-sponsored pot luck dinners, couples' clubs, etc. The Chamber of Commerce will give you a list of the names and addresses of local civic groups.

The "big time" is your local radio and television stations and newspapers. If you can pull off a major public event: an energy fair, a big L-5 meeting with an interesting program, etc. you may be able to attract a newspaper reporter or camera crew. Be sure your event doesn't flop, or your name is mud!

News Releases

How are you going to grab the attention of the media? One way is the news release. The ABC's of news releases are as follows:

a) Identify your group in the upper left hand corner.
b) In the upper right corner give the date and the time at which the news is to be released below it. (Most press releases say "for immediate release".)
c) Use wide margins and double spacing.
d) Include all the facts and be accurate. Check and double check times, dates and the spelling of names. Be brief: if you can't fit all the material on one page it's probably too long.
e) At the end give a name and number where more information can be obtained. Make certain that phone is covered at all times.
f) Timing is important. Learn when the deadlines for you local media are and get the news releases to them well in advance. For best results, deliver them in person. Appearances count: look sharp, and be extra polite. Learn the names of all the people who handle your news, and address news releases to them personally, or ask for them when you hand deliver it.
g) When you do get coverage, always thank the reporters responsible, even if you feel they did a poor job. Remember, no matter how bad the publicity is, they can always do worse. (Fortunately, nearly all reporters seem to be biased in favor of our work; our files at the L-5 office are packed with friendly news clippings.)

Send orders to: L-5 Society
1620 North Park Avenue
Tucson, AZ 85719

Public Service Announcements

Do you want a crowd to show up for your lecture or L-5 chapter meeting? If it is held by a non-profit group (such as L-5) you can get *free* public service announcements on your local TV and radio stations. Here are the ABC's of public service announcements:

a) Identify your group in the upper left hand corner.
b) Use a small index card. Type with all capital letters, triple spaced.
c) Tell what's happening, when and where. The address isn't enough; give the location ("corner of Main and 3rd", "west side of campus", etc.). Then tag it, twice, if possible, with a phone number for further information—a phone that will be covered day and night!
d) Time the announcement for 10 or 30 seconds, no longer.
e) Deliver your PSA at least 2 weeks in advance. Mail is OK, but hand delivery is better. As with press releases, look and act your best when calling on a station.

The slides in this catalog were provided by NASA, Boeing, Rockwell, and Arthur D. Little, Inc.. They are the same slides that top space researchers have used in presentations at conferences, Congressional hearings and television appearances. Have a good time as you join them in spreading the good news!

Clearance Sale

We have discontinued 27 slides from the old L-5 slide catalog: 108, 117, 201, 203, 204, 205, 206, 217, 218, 219, 220, 221, 222, 224, 225, 226, 227, 228, 312, 408, 410, 411, 412, 413, 414, 416, 417. These slides are on sale at 25¢ each while they last. A copy of the old slide catalog is available upon request.

THE L-5 SOCIETY SLIDE SHOW
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Continued from page 4

of any one nation or region, with one critical exception: energy."

Many economic studies have examined the strong correlation between energy consumption and economic strength. A strong correlation indeed exists. One can argue from this either that (1) abundant low cost energy is essential to economic well-being, or (2) a strong economy will consume a lot of energy if energy is abundant and cheap.

There are measures of truth in both views. The way the U.S. gross national product tracked the dip in energy consumption in 1973-4, that in turn resulted from the sudden increase in the price of foreign oil, tends to support the former view. The widespread use of large "gas-guzzling" cars in the U.S. is an obvious example of the latter view.

Patterns of energy use tend to be institutionalized in many ways. In response to a sudden increase in energy cost (or decrease in supply), one could:

- Turn down the thermostat: no capital cost, perhaps a little discomfort
- Carpool: no capital cost, some inconvenience
- Put more insulation in the house: small capital cost
- Buy a small car: large capital cost unless one was going to buy a car anyway

And so on. Similarly, industry can equip with more efficient machines, etc. But most conservation measures take time and cost money–capital that is siphoned away from investments that would result in growth.[2]

The degree to which conservation can limit our energy consumption without a major dislocation such as a severe economic downturn with massive unemployment and other problems is unknown, but certainly limited. Policies that emphasize conservation are likely to disproportionately burden those that are now economically disadvantaged. Last winter, the NAACP issued a report on its considerations of energy policy [6] that clearly recognized this fact. A representative quote: "–We cannot accept the notion that our people are best served by a policy based on the inevitability of energy shortage and the need for government to allocate an ever diminishing supply among competing interests." Well said.

The most widely used energy resources today are oil and natural gas. It is generally recognized now that oil is a critical resource. Substantial controversy exists regarding the exact degree of scarcity[3] but most of the controversy seems to be centered around whether a supply crisis will occur before 1985 or somewhat later, after 1990. Neither of these is a particularly attractive prospect. 1990 is only 12 years away. History indicates that the time required to develop and introduce a new energy source and bring it into principal use is 50 to 60 years. In other words, if we started today to convert to a major new energy source we could hope to have a transition more or less complete by the year 2030.

The use of coal has been viewed in some quarters as a panecea, a sufficient answer to our energy needs. The impression has been created that supplies of coal are either infinite or at least so very large as to represent a long-term supply. Quantities sufficient for hundreds of years have been discussed. This figure, however, applies to the United States only and to current levels of coal consumption. A study by Hubbert [7] however, indicated that world coal reserves could be relatively quickly consumed if the world turned to this source as a primary resolution of the energy problem. And the reserves may not be as large as once thought. Quoting a UPI/AP news item in the Seattle Times of January 29, "The General Accounting Office said only half of the nation's estimated coal reserves may be recoverable."

The widespread use of coal is also not without environmental impact. Strip mining and air pollution are often cited; more significantly, climatologists have expressed concern that the use of coal as a primary energy source for the next 50 to 100 years could cause worldwide climatic changes. George Woodwell writes [8] "Mankind therefore faces a historic dilemma. The human activities that are increasing the carbon dioxide content of the atmosphere promise to bring a general warming of the climate over the next several decades. –the results–will almost certainly be destabilizing." (Woodwell considers deforestation as well as fossil fuel consumption to be significant causes of carbon dioxide increase.)

Climatic changes would affect world food production, probably negatively, and sufficient warming could begin melting the great arctic and antarctic ice caps, resulting in a general rise in sea level by possibly as much as 100 meters. The economic and social consequences would be devastating.

We are indeed faced with a profound dilemma. Although the energy problem is at the heart and the focus of this dilemma, the dilemma is broader in scope than just energy. Until very recently in history, say until 1900, mankind was an incidental tenant of the Earth's ecosystem. We didn't consume very much or create much disturbance. We have now, however, become a planetary force. Our activities threaten to poison the oceans, foul the atmosphere, destroy the forests primeval, and pave the fruited plains with concrete. Uncontrolled growth is abhorrent to many people and would probably be ultimately disastrous. The problem of exponential growth was originally voiced by Malthus as long ago as 1798. It has recently stimulated the doomsday philosophies of the limits-to-growth studies, and the less draconian concept of "alternatives to growth." The prescription provided by "alternatives to growth" generally requires limitation of population growth, recycling of raw materials, and confinement of energy consumption to renewable resources such as solar energy, wind energy, biomass and so forth. This prescription often contains an ideological distrust of big government, big institutions, and big business. Its current buzzwords are "soft technology" and "decentralized energy." A utopian vision is often hinted at, a vision of peaceful small communities living a happy pastoral, self-sufficient, hand-crafted existence with roof top solar collectors and family farms. The "soft technologies" of solar and wind energy are, however, neither soft nor low in cost [9].

If uncontrolled growth may be disastrous, I don't think the soft technology road is much better. I discussed my views of hazards of limiting growth in an economic sense in my previous article. I don't believe there are any satisfactory alternatives to growth! The entire fabric of recorded history attests to the fact that when growth is constrained, the strong prosper at the expense of the weak. (They tend to do so even when growth is not constrained). The various social and political experiments that have been carried out in the world have not changed this fact; they have merely altered the rules that determine who shall be strong.

My vision of the soft technology road is one of pervasive control by rigid government bureaucracies charged with administering the allocations of scarcities, of severely restricted personal freedoms; of widespread poverty and unemployment; of urban jungles written off to decay and violence, or cleared by what might be called the "Cambodian solution."

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(1) Some enthusiasts for solar power satellites have had the idea that the anti-nuclear movement would support SPS. Predictably, it does not [1,2].

(2) An energy-economics model should recognize the time lag and cost factors of conservation. We will try such a model in a future article.

(3) One of the difficulties is that all of the analysts are probably depending to some degree on the oil companies as the ultimate source of data on reserves. There are evident reasons why the oil companies would wish to underestimate their reserves.

Industrialized society is approaching a level of overall productivity that can afford to support all its members at a level above mere subsistence, and provide something near an adequate level of medical care to everyone. One success of this society is indicated by the continuing increases in life expectancy on the part of its members. But the economics of this society is based on growth.

So we have our profound dilemma. Should we continue with a social order that accommodates our human nature of agressiveness, expansiveness, growth, and improvement with possible eventual consequence of catastrophe, or should we transform ourselves into a kind of recycling-limited treadmill society, including whatever social changes e.g. establishment of a totalitarian state, may be necessary?

We have talked of two philosophies regarding the limits to growth. One philosophy is to ignore the limits, the second one is to observe them slavishly. There is a third philosophy, one that asks, "why not remove the limits?"

If we are to essay such a philosophy, our most immediate concerns are supplies of energy and food. Small may very well be beautiful, but it is not sufficient. Development of abundant new energy resources would help to alleviate the food problem, since high-productivity agriculture is energy-intensive.

There are three new energy options that offer some promise of being able to support continued economic growth. These are the breeder reactor, which would increase fission fuel resources roughly 100-fold, the thermonuclear (fusion) reactor, for which limitations in availability of the (exotic) construction materials are more limiting than the availability of fuels, and the solar power satellite, for which no meaningful limits on eventual energy abundance are evident.

These options all have potential limitations or problems. A sensible energy policy will pursue all three with equal vigor[4], as well as other options such as decentralized solar and biomass, these latter likely to be much more important in the future than they have been in the past. The mechanics of transition from our present temporary energy sources, to the permanent ones of the future, are not presently very clear, but the ultimate need is compelling.

Development of adequate undepletable energy supplies will not remove limits to growth; it only can move the crisis horizon from about 10 to 25 years away to about 50 to 100 years. In the longer run, we are driven to what Krafft Ehricke has called the "extraterrestial imperative." All of the space pioneers–Tsiolkovsky, Oberth, von Braun, Goddard, Ehricke, recently O'Neill, as well as others, have in some way recognized this. But philosophy alone no more suffices as a justification for going into space in a big way than it does for soft technology. Hard economics must rule. (The job of building solar power satellites simply does not, in economic terms, demand colonization of space.) So which way does the road in space lead? This is a difficult question we will explore in future articles.

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(4) Lovius, A. B., and Price, J. H., Non-Nuclear Futures: The Case for an Ethical Energy Strategy, Friends of the Earth International, 1975

(5) Heiss, K. P., "The Energy Problem: The Need to Develop Policy Options," Statement for Record, Hearings Before the Subcommittee on Space Science and Applications and Subcommittee on Energy of the Committee on Science and Astronautics, U.S. House of Representatives, Hon. Olin E. Teague, Chairman, 1973

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(9) Murray, B., "Solar Energy: True God or False Prophet," Engineering & Science, March-April 1978

(10) Rose, David J. and Lester, R. K., "Nuclear Power, Nuclear Weapons, and International Stability," Scientific American, April 1978

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(4) The breeder reactor is the only one of these options that presently has demonstrated capability. The position of the current administration as regards the breeder has been observed to be rather curious [10]. Obstensibly for reasons of retarding nuclear (weapons) proliferation, a "go slow" posture has been adopted. For Western Europe, Japan, and many nations aspiring to industrialize, since no adequate alternative is offered, the reluctance of the United States to vigorously curb fossil fuel consumption and pursue new energy initiatives, leaves little recourse except increased emphasis on nuclear power, especially breeder reactors.

FASST to Study Student Input on SPS

Methods to solicit student input and to disseminate information on the topic of solar power satellites (SPS) are being examined by the Forum for the Advancement of Students in Science and Technology (FASST), under a planning contract awarded by the PRC Systems Sciences Company.

Notification of the contract award was recently announced by Charles E. Bloomquist, Project Officer for PRC, which is currently engaged in a three-year study for the Department of Energy to develop an initial understanding of the technical feasibility, economic practicality, and social and environmental acceptability of the SPS concept.

The PRC Systems Sciences Company is the world's largest diversified, professional services organization. It serves government, business, and industry, primarily in areas of planning, engineering, architecture, information sciences, and management consulting.

Results of the FASST, three-month, $9,500 planning contract will provide a better understanding of how to communicate SPS information to the college community, in order to encourage students to think in a realistic way about the development of this technology as a potential energy source.

During the study, FASST will identify methods that have proven successful in disseminating information addressing other contemporary issues, and methods to encourage students to become active participants in the discussion of these issues. The study will also examine models for conflict management which can be applied when presenting students with the wide range of opinions and attitudes that currently revolve around the SPS concept.

In commenting on the award of the contract, Alan Ladwig, President of FASST stated, "We are looking forward to this opportunity to improve student participation in the discussion of energy options for the country. We commend the foresight of the PRC Systems Sciences Company and the Department of Energy in recognizing the importance of having student participation in the SPS discussion. This is especially important since students will inherit the management responsibility of future energy systems being decided upon today."

According to Leonard David, Program

Director of FASST and Principal Investigator for this contract, "While this study concerns the communication of information relevant to a specific type of technology, the methods to increase student participation that will be identified may be suitable for application to other FASST science education programs."

The scope of this study project compliments the on-going efforts of FASST to develop new opportunities for student participation in the discussion of science issues, and to develop new approaches to resolve conflicting opinions on the direction of science projects.

"During a time, " Ladwig concluded, "when numerous groups, from both the business and non-profit sectors, are advocating cut and dried solutions to complex science problems, FASST must increase its efforts to develop new forums for these problems to be worked out and discussed."

In addition to Ladwig and David, the FASST study team will include Tom Schwab of Cornell University. Tom is currently participating in the FASST Summer Intern Program.

For more information, contact Leonard David, FASST, 2030 M St., Washington, D.C. 20036, 202/466-3860.

Omission

The article, "Space Habitats by Accident" in the July **L-5 News** was written by Leonard David of FASST.

"Living and Working in Space" Panel

The opening session of the 11th annual National Association of Industrial Technology Convention at the Jacksonville Beach Sheraton Hotel, Jacksonville, Florida will be "Living and Working in Space". This panel discussion session, from 8:45 to 10:30 AM, Thursday Oct. 19, 1978, will be chaired by Earl G. Mills of Hughes Aircraft Co., El Suguendo, CA, and will include presentations by panelists; Jerold Farrell, Hughes Aircraft Co., Los Angeles, CA, Charles L. Gould, Rockwell International, Downey, CA, and Jay Huebner, University of North Florida, Jacksonville, FL.

Individuals may attend without charge. It is hoped that groups planning on attending will communicate the number expected to be in attendance to Dr. Adam Darm, Division of Industrial Technology, University of North Florida, Jacksonville, FL 32216, so adequate space can be assured.

Inside the L-5 Society

Bylaws Votes

There were 504 ballots cast in the annual election. Bylaws changes require 2/3 of the votes cast to pass — in this case, 336. One bylaw change flunked: the amendment to Article XI, Part A reading "Approval by majority vote of a quorum of the Directors at any meeting of the Board of Directors". It only received 321 votes.

If you would like a copy of the new, improved bylaws, write L-5 headquarters at 1620 N. Park, Tucson, AZ 85719 and we will mail you a copy.

New L-5 Chapters

Ashland L-5
Box 1420
Randolph-Macon College
Ashland, VA 23005

Reno L-5
c/o Ray Bryan
1071 Glen Meadow Dr.
Sparks, NV 89431

Jacksonville L-5
c/o Penny Stombock
Star Route 1, Box 1208
Yulee, FL 32097
(Note: the organizational meeting will be held Friday, September 22, 1978 at 8 PM in the Jacksonville Museum of Arts and Sciences, 1025 Gulf Life Dr.)

Mankato News

The Mankato Space Society was formed in April of 1978 by members of the L-5 Society, the National Space Institute, the National Association of Rocketry, the American Astronomical and Astronautical Societies, The American Institute of Aeronautics and Astronautics, and other organizations, with the intent, because of our non-central location, of bringing those with the common interest in the utilization of outer space under the umbrella of a local, stronger, and more influential organization.

The purpose of the Society is to inform and educate the Society membership and the general public of the history, present condition, and proposed and possible future developments in all aspects of the utilization of outer space and related fields, and to conduct research in areas of interest to the membership.

The Society is sponsoring an Aerospace Week in Mankato during Sept. 22-27, 1978. Displays will be presented in two of the shopping malls and on the campus of Mankato State University (MSU) on such various aerospace topics as: Astronomy, Space Settlements and Industrialization, Civil Air Patrol Aerospace Education, Model Rocketry, Remote Controlled Model Airplanes, and the National Aeronautics and Space Administration. There will be speakers in MSU Centennial Student Union in addition to the displays, and a two hour Society program will be given the evening of Wednesday, Sept. 27.

The Mankato Space Society has been organized as a MSU recognized campus organization with membership open to anyone in our region. Anyone who is interested in participating in the Society's L-5 Concept project team or one of the other project teams to help produce and give public education presentations may contact the Society for more information at: Box 58 Activities Office, Mankato State University, Mankato MN 56001; or Dan Lundquist at 507/345-3624 or Brady at 507/388-6090.

O'Neill Lecture

The Chicago Society for Space Settlement will present Dr. Gerard O'Neill on Friday, October 20, at 7:30 P.M. in the Navy Pier Auditorium on Chicago's Lakefront. This show is open to the public without any admission charge. Mayor Bilandic has provided the Society with the use of the Navy Pier Auditorium as well as the parking facilities located on the pier itself.

BUT—to carry off the O'Neill lecture, the Society needs to raise $2,500.00 by October 1st. As of August, current pledges total $600.00.

In order to make contributions to this program tax-deductible, the National Space Institute has agreed to act as a "grant sponsor" for the lecture. This means that a donor who makes his check payable to the NSI and sends it to the Chicago Society for Space Settlement may write off the gift and the NSI will give the donation to the Society for the project. Donations can be mailed anytime to The Chicago Society for Space Settlement, 4 N. 186 Walter Drive, Addison, Illinois 60101.

The September meeting of the Chicago Society for Space Settlement will be held September 17, 1:00 P.M., the Midlevel lecture hall of the Adler Planetarium. The public is invited, and there is no admission charge. The Adler Planetarium is located at: 1300 S. Lake Shore Drive, Chicago, IL.

Tulsa L-5

The Tulsa L-5 Society conducted a panel discussion at Okon '78, held July 22-23 in Tulsa. SF writer Joe Haldeman and Tom Huffman, president of the Tulsa chapter, discussed the High Frontier concept and the L-5 Society, its history and current activities.

Haldeman mentioned the possibility of an auction at Worldcon (Phoenix, Aug. 30-Sept. 4) to benefit G.K. O'Neill's Space Studies Institute. Joe thinks some SF writers would be willing to donate manuscripts to be auctioned off; he'd be the auctioneer.

Quite a few people stopped by our table in the hucksters' room; more than 40 of them signed their names to a list indicating an interest becoming members of Tulsa L-5. Other chapters may gain members from the out-of-towners who expressed interest in joining; some new chapters may even be formed.

With the people we picked up at the "con", added to our small core group, we should have enough people for an active chapter. We're already planning a careers in space symposium and a poll of local interest in an expanded space program.

If anyone in an established chapter is interested in giving advice to a fledgling group, write to: Tom Huffman, pres., Tulsa L-5 Society, 3424 E. 41st, Tulsa OK 74135 or phone 918/743-4942.

VA Tech L-5

New officers have been elected to direct activities of the Virginia Tech Chapter of the L-5 Society this coming school year.

President is Cindy Hartman, a public administration major from Springfield, VA. Vice President is Billy O'Donovan, majoring in engineering; secretary is Mark Turner, a public administration major; and Allen Jones, an engineering major is the new treasurer.

Miss Hartman explained the goals of the chapter as being one of spreading the ideas and benefits of space colonization.

"We will be preparing audio-visual presentations on a wide variety of subjects for use in high school and junior high science classes," she said.

Miss Hartman described the presentations as covering subjects from space habitat design to applications of spin-off technology.

"The variety of subjects available will present challenging areas related to space colonization for all chapter members to research and participate with," she added. "This should keep our chapter busy for years to come."

Sounds of Earth

The 120 minutes of the "Sounds of Earth" recording installed on Jupiter-bound Voyager-1 and Voyager-2 may be sold commercially to coincide with probe Jupiter encounters in March & July 1979. The record consists of 22 minutes of sounds and 98 minutes of music.

The record was put together by CBS records in New York, which owns all rights. NASA has tapes which can be used for news and information purposes. Contact Jim Kukowski, Audio-Visual Office, NASA Headquarters, Washington, D.C. 20546.

The Future United States Space Program Conference

October 30 through November 2 the top space researchers in the U.S. will gather in Houston to chart out future efforts. This gathering will cover everything from space science to nuts and bolts space engineering to "people problems".

If you want a crash course on the options opening up in the U.S. space program; if you want to meet and talk with the top space researchers in the nation; if you want to be one of the several hundred people who know and care the most about our future in space, then you'll want to make it to this conference.

The "Future United States Space Program" conference is cosponsored by the American Astronautical Society and the L-5 Society, among others. Hope to see you there!—Carolyn Henson

Advance Conference Registration

TO: **The American Astronautical Society**
1830 NASA Road 1 LEC Mail Code D-01
Houston, Texas 77058

Don't forget to take your L-5 members' discount when filling out your application.

ADVANCE REGISTRATION:

(Members)	☐	$20.00 one day	(Student)	☐	$ 5.00 one day
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(Non-members)	☐	$25.00 one day	(Banquet)	☐	$15.00
	☐	$70.00 four days	(Awards Luncheon)	☐	$10.00

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Fresno L-5

We wish to thank you very much for sending us the L-5 reprints which we passed out at our booth at the Diablo Canyon Rally and Alternative Energy Fair.

Our display generated a lot of interest and the reactions were varied. About ten percent of the people were openly hostile. A typical comment was: "Oh no! This is totally out of place here." Another fifteen percent were openly supportive. You can expect a few new memberships. The rest ran the whole spectrum in between; skeptical, puzzled, curious, and interested. Nearly everyone asked, "What about the microwaves?". Others said, "We can never afford that.". I found it helpful to tick off a point by point comparison of the SSPS and nuclear power plants and to mention the cost of foreign oil. This leaves SSPS smelling like a rose and caused even tough skeptics to ask for more information.

At the rally and during the preparation prior to it, I made friends with several people from the Abalone Alliance and our local anti-nuke activist group, People for Safe Energy. Most of these people are committed to, as they put it, replacement of "hard" technology by "soft" technology. They tend to initially view space industrialization as "just more of the same", meaning control and manipulation by the major power companies. They seem to be grasping for something elusive, however, since I think that most of them realize that the conversion to soft technology would lead to economic stagnation and a largely uncertain future. When I mention the possibility of utilizing extraterrestrial resources to put the lie to the concept of limits to growth some of them become enthusiastic almost, it seems, in spite of themselves since this is near heresy to the ideals of decentralization. I think that, if approached in the right way, these types of activist groups could yield some very intelligent dedicated space supporters.

Gale M. Smith

Fresno L-5 booth at the Alternative Energy Fair. Seated on the right are Lynne Percy and Eric Forster. (Photo courtesy Gale Smith.)

Hubbard to Appear in LA

October 17 at 8 PM the Theatre for the Future will present "Previews of Coming Attractions", starring Barbara Marx Hubbard. Ms. Hubbard, an L-5 Society director and noted space activist, has been showing her audiences that our expansion into space is an evolutionary imperative.

The show is cosponsored by the World Future Society and American Institute of Aeronautics and Astronautics. Location is the Union Oil Auditorium, 461 S. Boylston St. (west of the Harbor Freeway). Admission is $2.50.

Final Frontier

Two new programs, now available in 16mm and videocassette, have been added to Time-Life Multimedia's critically-acclaimed NOVA series. The new releases, which were produced by WGBH and originally aired on the PBS network, are: "One Small Step" and "The Final Frontier."

With "One Small Step", NOVA marks the 20th anniversary of the first American venture into space. It examines the history of space exploration and the technical—as well as political—considerations that influenced it through July, 1975, when the first Soviet Soyuz and the American Apollo rendezvoused in space and the space race officially ended.

"The Final Frontier" investigates the

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NAME: ____________________

ADDRESS: ____________________

CITY/STATE/ZIP: ____________________

AFFILIATION/TITLE OR POSITION ____________________
(OPTIONAL)

I am____ am not ____ interested in being active locally. Phone (optional) ____________________

____ Please enroll me as a member of L-5 Society ($20 per year regular, $15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of $12/year included in membership dues).

L-5 Society members who sign up for the Space Legislation Hot Line option receive frequent first class mailings on the actions of Congress and the President which affect the space shuttle, space colonies, solar power satellites, space exploration and other space projects.

____ Sign me up for the Space Legislation Hot Line.

premise and promise of space colonization: regularly scheduled space shuttles, extra-terrestrial manufacturing and agriculture, and untapped and perhaps unlimited sources of raw materials and energy. Already NASA is testing "Getaway Specials" to outer space and mounting a marketing campaign to convince American industry that space is the place to be, and scientists predict that by the year 2177 more people will live in space than on Earth.

For more information on obtaining tapes of these programs, write to WGBH Educational Foundation, 125 Western Avenue, Boston, MA 02134, phone 617/492-2777.

Letters

This question may only reflect my ignorance of "the market", but I'd rather be laughed at by you than by a stockholder! In reading the **Laser Propulsion** article in the July, 1978 **L-5 News** (which I received 3 August, about usual), I got the flash - 'why not invest money in one of these brilliant, new, little, space-oriented companies, like AVCO Everett Research Laboratory, a la Xerox when it was young?' I am convinced that the utilization of Space lies in humanity's future—so let's get going! Right now my largest asset is the cash value of my life insurance policy, which, at my age of 26 - and considering I seriously intend to live another six score years - seems a pretty silly use of my resources. Now the question: where does one get the names and profiles of such budding companies? Does a list exist, or are there brokers who specialize in this interest, or is this something the **L-5 News** can help put together?

Thanks for your help.
Aloha,
Ron Lichtwardt
Honolulu, HI

Details on companies which interest you can be located in **Moody's Industrial Manual**, *available in any good library —CH*

Why should we spend $20.5 million for the Teleoperator Retrival System? From what I read in Henry S.F. Cooper's **A House in Space,** the problems and living conditions of Skylab warrant a totally new system. An updated version of Skylab could be a predecessor to Space mini-colonies. Would this not be a more fruitful course to follow? Let the old system come tumbling down, but not on me, and use the money for R&D into a new and different "Skylab". Unless the Teleoperator Retrieval System has other important uses, I cannot lobby for it as part of a NASA budget. I feel that Skylab won't be there to save and will be stuck with a $20.5 million Teleoperated Anemic Pachyderm. The same seems applicable to Spacelab II. In the absence of a better arguement, I must lobby against these items in the NASA appropriations bill.

Live long and Economically!
Keith Kuhn
Lewistown, Pa.

I propose that we make up our own award to be called the golden turkey consisting of a statue of a turkey with its head on the chopping block. The first person to receive one should be none other than Senator Proxmire for making a fuss over the SETI appropriation. The $2 million requested this year when compared to the national debt of 675 billion amounts to a savings of 3 ten thousandths of one per cent ($3x10^{-6}$). Never has one done so much to hinder the expansion of human knowledge at so little savings. In fact, the $2 million would only be 2% of the cost of the new Senate office building. As for being against the teleoperator system, I hope Skylab comes down in his back yard.

Michael C. Strong
Swartz Creek, MI

I am opposed to developing solar energy stations in space because it is not cost effective and, further, will not produce significant energy potential. Rather, I fully support the development of fusion energy.

At this time, the U.S. does not have a comprehensive energy program. The Soviet Union, in conjunction with the Socialist bloc does it the following way: massive financial, economic and scientific development of fusion energy and space exploration. While we reinvent the wheel (solar energy), they will leave us far behind. Unfortunately, it will take a new "Sputnik" to change the prevailing intellectual climate.

Thomas Scanlon
Brooklyn, NY

On page 20 of the January 1978 **L-5 News** is a letter: "L-5's Achilles Heel?" I cannot agree with Mr. R.G. Lovell's opinion. The solar power satellites are stations which can be moved all around our planet at any place where energy is needed. The deep well geothermal plants imply a very strong study of new materials resisting the high temperatures of magma and lava, and the creation of a liquid resisting these temperatures. The problem of solar-energy transmission by microwaves seems to me to have been studied much more profoundly and therefore much more advanced in its creation.

On page 21, Mr. Michael Mautner, Ph.D. discusses "Corrosion Questions". Still it seems to me premature to examine space colonies' structural materials. I will only mention an article indicating the tremendous quantity of nickel to be collected form an asteroid, which means that large quantities of oxidation and/or acid proof sheets can be laminated for space-purposes. Another solution may possibly be the vitrification at low cost of usual sheets.

But, as I mentioned before, I consider the creation of space colonies as a second step. The main purpose of L-5 ought to be the creation of the SPS and the large income which will result from the supply of the cost free solar-energy which will pay the investment made and then build up the funds necessary to proceed to the second step: space-colonies.

Stefan Cantacuzino
Master of Technology
Huddinge, Sweden

Eric Drexler's article "The New Space Program" was very interesting, and very true. If we (members of the NSP) don't come together on our goals, we will never be able to get anything put up in space, much less any form of space habitat. NASA already has congressmen and Senators tearing its budget apart left and right. It certainly doesn't need to have civilians tearing down every idea they put up because it opposes their pet project.

Jonathan Henderson
Hodgenville, KY

Words of wisdom from Dr. Frosch: "The system has now sharpened its pencils in a way that discourages changes that are major. We have been so busy with other things that we may have inadvertently told the people who think up ideas to go away." (Vanishing Innovation, **Business Week**, July 3, 1978, p. 46-54, specifically page 49) Aargh!!!

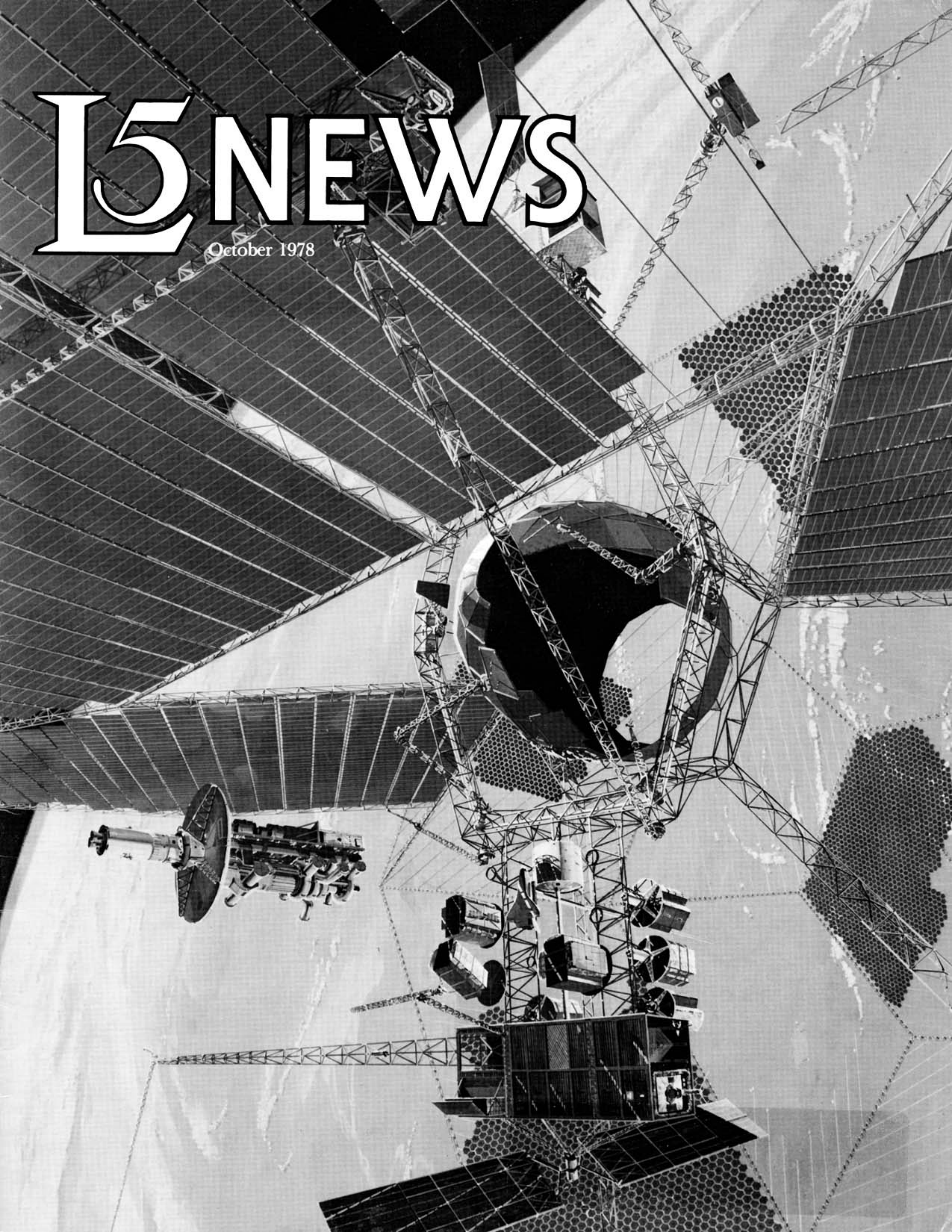
Charles J. Divine
Trenton, NJ

Congratulations on the L-5 editor's new daughter. I suggest that you train her as a pipe-fitter/metal worker, with 1995 in mind. Looks like about the best way to get off the world then: a useful skill plus EEOC pressure, there being few female pipe-fitters.

Jack Salmon
Pensacola, FL

L5 NEWS

October 1978



L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 3 NUMBER 10 OCTOBER 1978

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1 **NASA-Supported Study at the University of Arizona Selects Crops for Closed Habitats in Space** *by Annita Harlan*

2 **Children of Gaia** *by Erik T. Patterson*
L-5 Symposium *Tony Davis reports.*

3 **The Prisoner and Space** *Lawrence Brozik points out that prisoners, the historical mainstay of colonization efforts, are ready and willing to try it again.*

4 **Big Facelift at Kennedy Center**

5 **SPS Hearings** *Ken McCormick reports on the clash of solar power satellite supporters and opponents (continued from last month).*

9 **Facts and Fallacies of Space Warfare** *by James Oberg*

12 **Bibliography Update** *by Conrad Schneiker*

14 **The Future United States Space Program** *Carolyn Henson reports on preparations.*

15 **Inside the L-5 Society**

17 **Letters**

Cover: Construction of the heat cavity of a solar power satellite *(courtesy Boeing).*

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An office at the Environmental Research Laboratory. The plants seen here produce about one kilogram of vegetables per day every day of the year. These intensive cultivation techniques may some day be applied to growing food in space.

NASA-Supported Study at the University of Arizona Selects Crops for Closed Habitats in Space

by Annita Harlan

What to eat and how to raise it during years of space habitation are issues being addressed by a team at the University of Arizona's Environmental Research Laboratory in Tucson. Under the direction of Research Associate John Phillips, a diverse group including library specialists, biologists, and a student of psychology are considering the literature on closed environment agriculture (CEA) in search of likely food sources for space pioneers and permanent inhabitants.

The study came into existence in order to cover gaps in knowledge uncovered at the 1977 NASA-Ames Space Settlement Study which was attended by two of the team members. It has centered on collection of published works which detail the methods used in growing crops and raising animals not under field, but under enclosed, conditions. Increased yields are usually realized by CEA, and economies can be made in materials, such as nutrients and water. Recycling in controlled loops, an imperative for space habitations, naturally derives from CEA practices.

With compilations of candidate species, their yields, needed feedstuffs and spatial requirements in hand, the ERL team will be making specific recommendations to NASA in several areas of RT&D. Among them will be: utilization of space shuttle to study systems and components. Development of a dedicated long-duration exposure facility for life sciences research. Initiation of quantitative studies in earth-based phytotrons. Continuation of interdisciplinary forums to promote developmental interaction among industrial, governmental and university personnel interested in CEA. Expansion of the data base SIRS (Space Information Retrieval System) begun during the study.

The study will be in progress until November 30, 1978 and the participants would welcome input from interested individuals.

Children of Gaia

by Erik T. Paterson

Living creatures not only respond to their environment, but actively change it. This is the prime principle of ecology, and the details of the flows of energy, water and nutrients within the ecological system are secondary. It explains the interdependence of living things.

The "Gaia Hypothesis" was named by William Golding and elaborated by Lynn Margulis and James Lovelock as an extension of this principle. It suggest that the entire biomass of the Earth is a single living entity, able to control and direct the changes in its own environment to ensure its own survival. Every organism does this, from the lowest to the highest. A unicellular organism is a metastable co-operative collection of molecules which, in themselves, are constantly changing each other and their environments for the sake of the survival of the whole. Similarly, an organism as complex as a human being is an equally metastable co-operative of cells changing each other and their environments. The hypothesis cannot be proved, but it offers powerful insights that can guide would-be populators of Space.

Up until now Gaia has been unable to perform the one activity shared by all its component organisms. It has failed to reproduce itself. It cannot reproduce itself because it has not been able to evolve the necessary mechanisms to be able to move parts of itself off the surface of the Earth and into space, the only place into which it can divide without destroying itself by self-competition.

But now, in the shape of some derivatives of the hominids, Gaia may have developed just that mechanism by which, after 3½ billion years, it can reproduce itself. If we choose we can establish independent colonies in space. But those colonies cannot survive long unless we learn the lesson of Gaia. We have to take with us a sufficient variety and diversity of other organisms whose own interactions and modifications of their environment will permit us to live. But they, in their turn, will depend for survival on the modifications in the environment of space that only we, with our technological expertise, can bring about.

It is one of the chief ironies of our age, that we, who threaten Gaia's very survival, can be the means for the spread of Gaia's children across the Universe.

L-5 Symposium

by Tony Davis

What are the chances that your cozy little mecca in outer space will be destroyed by a terrorist attack? By a killer virus? By a flood of radiation? How will we get along up there? Will it be governed by the kind of social democracy, replete with trade unions and constitutional guarantees, that we know in the United States and Western Europe? Or will it be a less benign form of government, one that would make the Soviet Union seem humanistic by comparison, one in which the dregs of human existence would battle it out for survival?

These and other questions were explored last month in the L-5 Symposium held at the 36th annual World Science Fiction Convention in Phoenix, Ariz. Panelists were L-5 Society president Carolyn Henson and science fiction writers Mack Reynolds and Joe Haldeman, both of whom have novels in the works about space colonies.

In general, the outlook of the panelists was optimistic, and one of the reasons is the kind of people who are likely to settle in outer space. Comparing the colonizing of space with the colonizing of the Western Hemisphere, Reynolds noted that the immigrants from Europe throughout the ages were either some form of human scum — such as convicts or ne'er-do-wells — or refugees from an oppressive political atmosphere back home.

The crew that came over with Columbus, for instance, were not adventurers, said Reynolds. Instead, they were "the scum of Southern Spain who even were on the verge of mutiny. Columbus went over for money, you know."

The later Spanish settlers, led by Conquistadores such as Cortez and Pizarro, "were the most corrupt, depraved people you could find," said Reynolds. On North America, Georgia, for one, was settled by convicts. Many of its new residents — the slaves — didn't want to come to begin with.

Reynolds noted that the Irish who came to the U.S. to escape the potato famine in the 1840's were the lesser trained of their countrymen, while the better-equipped ones stayed on. Likewise, it was the poorer, less-trained Germans who fled Bismarck and Jews who fled the pogroms, he added, and the Italian immigrants mainly came from the poorer, rural areas of Sicily and Southern Italy.

The first space colonists, by contrast, are likely to be so intelligent, competent and well-trained that they could get a good job on Earth, said Reynolds.

But someone from the audience shot back that "the people who leave here — are they the ones who louse up to begin with?"

Henson, meanwhile, predicted that Earth will eventually become a giant park, maintained by space dwellers for their amusement — "the people will not be allowed to mess up their home planet.

"We can clean up Earth by leaving it. The only way out is up. We can't go back to our past ways."

What kind of government will we have up there? Again, it depends on who goes up first, according to Henson. Colonies that are largely corporate-dominated and founded primarily for the purpose of space industrialization — which is the most likely scenario for the early settlements— will probably resemble company towns, with the resulting corporate dominance over both politics and social life. A member of the audience suggested that the only way out of such a bleak future would be for the workers to buy controlling interest in the company, thus giving employees more control over their lives.

Asked about the possibility of a terrorist blowing a hole in a spaceship, Henson replied that on Earth, an offshore oil platform would be a much easier target, since it could be sabotaged by little more than a good monkey wrench. Yet terrorism has never struck one. She said security measures need not be more tight than on a nuclear submarine, where the only persons who are screened out before boarding are those who have been getting in trouble with the Navy.

"Most people are a heckuva lot more stable than social scientists would have you believe. Terrorism is not nearly as rampant as believed," she said.

Other suggestions from the audience for combatting terrorism in space included an "absolute death penalty for upsetting the system" and to "take precautions — Don't let any Italian politicians along".

As for the prospect of a disease-racked space colony, Henson argued that it isn't as likely as a plague striking a large city.

"New flus don't come out of Tahiti. They come out of China. You need a large body of host organisms to generate new diseases.

"On bases in Antarctica, for instance, they'll go nine months in the cold with no contact with the outside world and be healthy, then they'll get their first piece of mail and all catch colds and flus."

Reynolds, however, warned that a group of space colonists living a disease-free existence inside a rock shield could be easy targets for germs once they came back to Earth because they would never be able to build up any immunities. □

So you think, as Mack Reynolds does, that the days of prisoners as colonists are over? Lawrence Brozik, an inmate of the Florida Prison system, disagrees in . . .

The Prisoner and Space

"Today, one hundred of Florida's deathrow inmates were taken from their cells and were transferred to the KENNEDY SPACE CENTER (KSC) which is situated in southern Florida. Training under super maximum security conditions will take place, and each of these prisioners will be sent to the Lunar Service Station I site within the next twenty-four to thirty-six months." (Future news circa 1980.)

Such a scenario as the above is not absurd.

I think the facts will bring us to conclude that "THE PRISONER IS OUR MAN."

Many of the world's pyramids were assembled by the prisoner of yesteryear. For much of the recovered art and anthropological data, we are indebted to their service. Thank you, prisoner.

When England was into the business of colonizing America, few Englishmen could be induced to venture away from "home", even when gold was offered as an inducement. So England turned to her dungeons and asked the prisoners (with death and life sentences) if they would consider going to America. England was "surprised" to find so many colonizers/explorers in various of her dungeons. The prisoners, it was learned, sought to be frontiersmen as opposed to being practice material for the executioner! Thank you, prisoner, for settling America.

When our forefathers were going west, once again the prisoner was used for building roads and bridges. Thank you, prisoner.

When the continent of Australia was in need of colonizing, the prisoner was used again. Thank you, prisoner.

There are cases upon cases where without the prisoner's contribution there would have been major lags in our development. The prisoner has contributed significantly to national expansionism, resource development, technological advancements and scientific contributions. The list is long. Thank you, prisoner.

Let us examine how the "free-person" thinks v.s. the prisoner.

A. The free-person has certain basic thoughts and ideas which make up his or her Gestalt. Examples:

I. Today is a special day and I wear a special color outfit of clothes. I do this because I am Irish.

II. It is Friday night and I must go to the discotheque to be with my friends.

III. This is my house and new car, I am very happy.

IV. I often have a spontaneous desire to go for a midnight walk down to the bay, and I enjoy it.

V. I don't want to go to a certain place, so I won't go.

VI. Linda Sue and/or John Paul will say they want some sex or love tonight.

VII. Space colonization and manufacturing facilities are pure hogwash! Furthermore, I am not leaving my house and friends for any longer than a few weeks. Let's make Earth happy first.

B. The prisoner has certain basic thoughts and ideas which make up his or her Gestalt. Examples:

I. There is nothing special about today and my clothes will be the same color as yesterday even if I am Irish.

II. It is Friday night and I will go nowhere that I didn't go last night. I will go to my cell. I have few, if any, friends. Anyhow, they usually represent a liability!

III. This cell is not my house, and I have no house. Nor do I have any car. I am not happy.

IV. I have no spontaneous desire to go for a midnight walk down to the bay, because I cannot go.

V. I may not want to go to a certain place, but I will go if I am told to go.

VI. Sex. Two guesses what's available.

VII. Space colonization and manufacturing facilities are TALLY HO! Yes, I will leave this cell to go to a place which offers more choice.

Due to the high cost of per kilogram of mass delivered to the Lunar surface, this discussion will use small dollar numbers. Although these are not meant to represent actual costs, these figures will, nonetheless, get us to our conclusion.

The free person, it has been learned, wants a round-trip ticket so that he/she can first go to the Moon to sort of "look it over." The whole space scenario is, to quote Gerard K. O'Neill in "Space Manufacturing Facilities" (**Space Colonies 1977**), ". . . a concept which is still, for many people, very rich in future shock." The prisoner, however, unequivocally says, "Yes, I will go, even if it is forever." This brings us to some real dollar considerations:

If the free person goes to the lunar surface with the Space Transportation System (STS) etc. pledged for his or her short duration return, the cost is phenomenal.

Let us suppose that the cost from the Earth's surface to the lunar's surface is exactly one dollar. Let the same stand for a return trip. Thus, we have a round-trip for the cost of two dollars. Let us also suppose that the free-person will go on the roundtrip at a wage scale double that of the Alaskan pipeline workers; wages, then equal about ten cents for his/her short duration venture. Also, for the same time period, society in general, has been housing and feeding a prisoner for a cost of five cents. Grand total cost to the tax-payer, then is two dollars and fifteen cents. And what we get is not much done on the lunar surface.

If, on the other hand, the prisoner goes and no Earth resources (H and O plus complex STS, etc.) are pledged for his/her return, the cost is much less.

For example, if the prisoner goes on the one-way venture, the cost is one dollar. If we subtract the housing and feeding costs if he/she had remained in prison, it brings the cost to ninety-five cents.

"They set up the Lunar Service Station I, fed lunar resources to the space manufacturing facility where the first space colony was built, which in turn built the solar power satellite (SPS) which now powers New York." (Future news, circa 1995)

Could we thank the prisoner again?

IN CONCLUSION:

Sending the prisoner to space is proposed by reason of history, psychology and economics:

The prisoner has developed new frontiers in the past and will do it again. The lunar envionment is hostile and Florida's large death-row has prisoners who are willing to go.

(NOTE: Today, 1978, there are plus one hundred condemned prisoners on Florida's death list and these prisoners are housed close to KSC.)

Reader opinion on this paper is sought and all letters addressed to the author will be read as a source of feedback. Please address your letters to LAWRENCE BROZIK No. 040717, BOX 221, RAIFORD, FL 32083. Also, should you write your Congressperson, etc. on the use of prisoners in space, thank you.

ABOUT THE AUTHOR:

Lawrence Brozik is a prisoner in the Florida prison system, serving a fifteen year sentence for manslaughter. He is a graduate of the Associate of Arts degree at honors and a continuing student of psychology and psychiatry. He is to be released by 1981. He is a licensed commercial pilot with plus fifteen hundred hours of safe flight logged and a member of the L-5 Society.

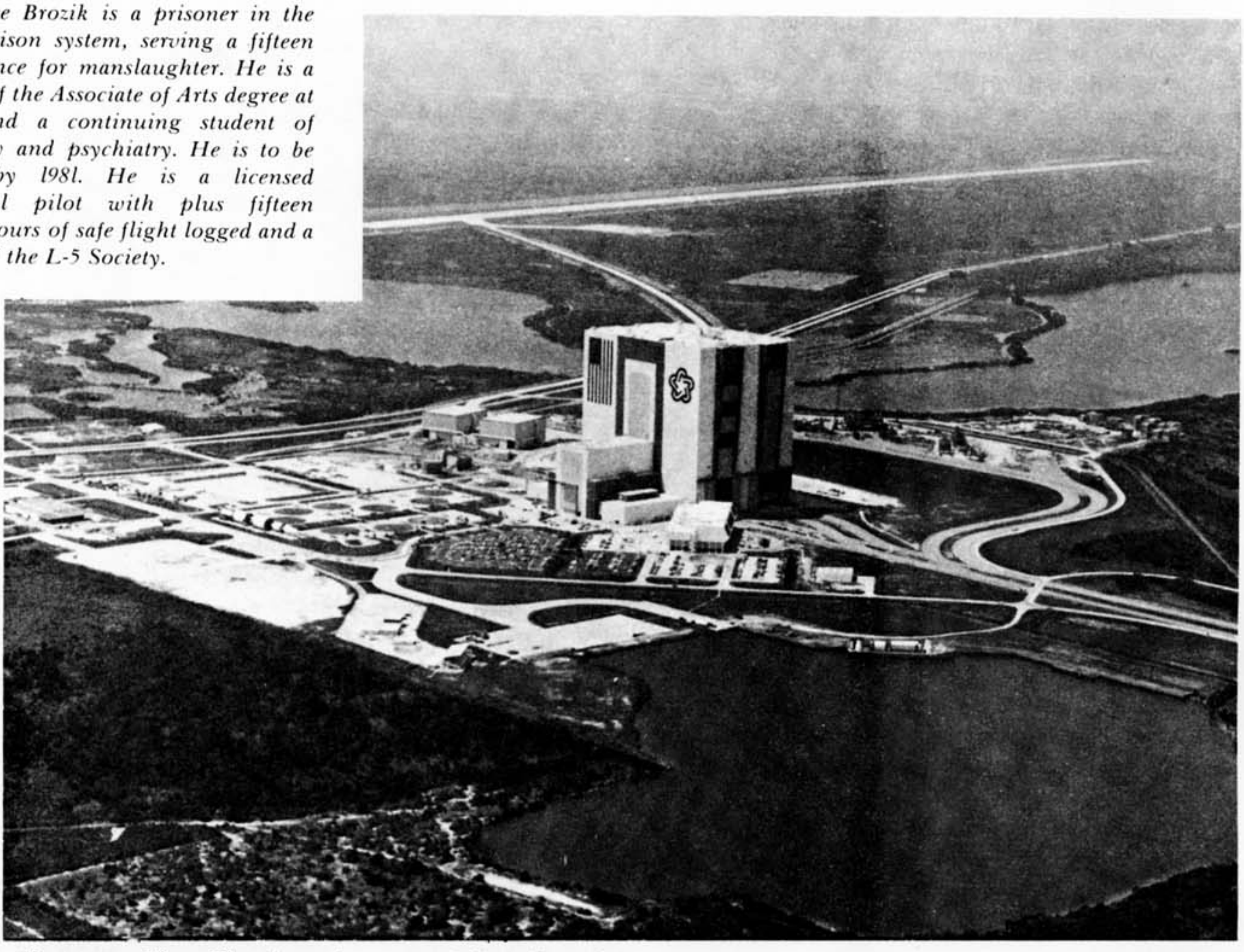
Immense Crawler Transporter—Massive loads will be carried on the top deck—the size of a baseball diamond—of this transporter. It will be used to move mobile launcher platforms with the assembled Space Shuttle between the VAB at the Kennedy center and two launch pads at complex 39.

Big Facelift at Kennedy Center

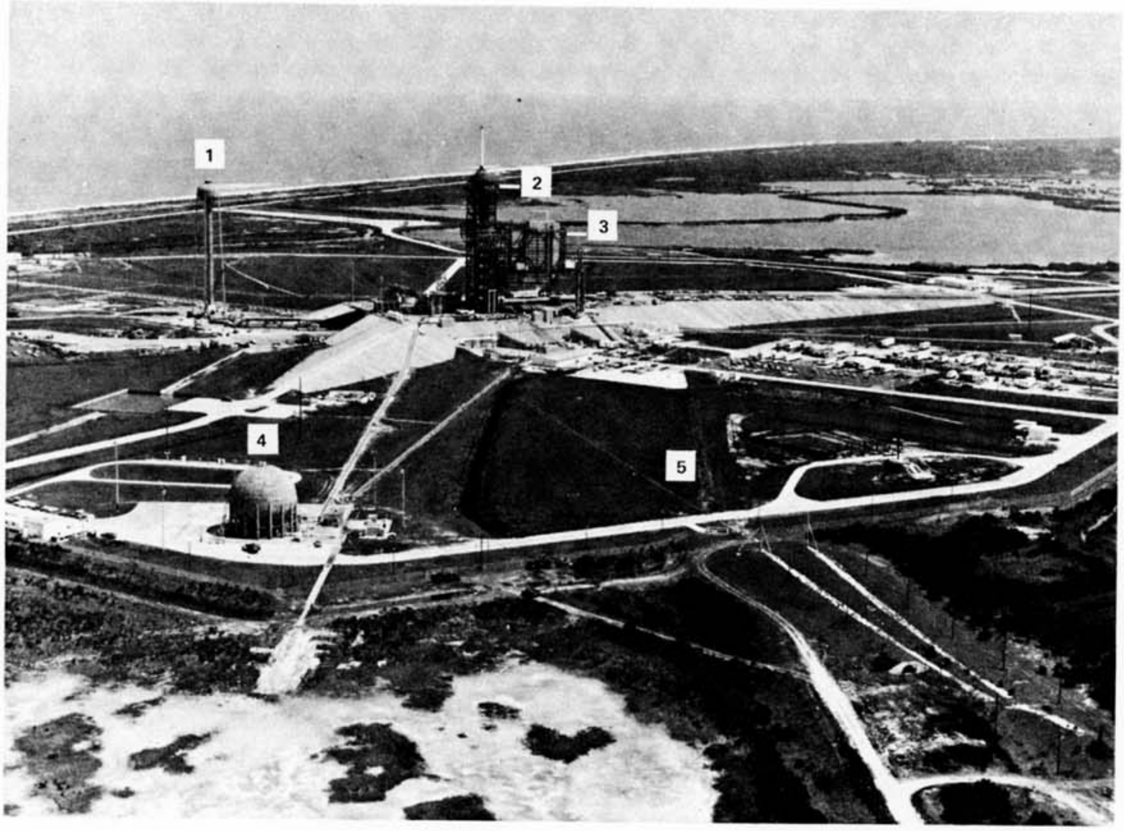
The changes, refurbishments and new construction going on at the Kennedy Space Center are many and varied as the center braces for a whole new era of space adventure following the arrival of the Space Shuttle next year. To accommodate the responsibilities involved, almost all the established facilities are being modified.

The tasks are to build or modify buildings and apparatus; design, build and acquire equipment and ground support facilities; and then install, wire up and interconnect the thousands of complex systems. Dr. Robert Gray, manager of the Space Shuttle Projects Office at KSC, is responsible for completion of the massive job.

The accompanying pictures show only some of the activities underway in preparation for the first launch of the Shuttle, now scheduled for June 1979.



Long-range View—This picture shows most of the facilities that will provide both launch and return accommodations for the Space Shuttle missions. When ready for launch, the orbiter will travel from the Vehicle Assembly Building to its launch pad (beyond right margin of picture). Upon its return, the orbiter will land at the strip visible at top of photo.



Looking Down at Shuttle Facilities—Shown are the 87-meter tall water tank (1), which holds 1,025,500 liters of water, built to protect the orbiter and its delicate payloads from acoustical damage during launch; (2) the fixed service structure (lightning mast at top) with rotating service structure (3) nearby—to provide access to the orbiter for changeout and service of payloads at the launch pad; the liquid oxygen facility (4) which supplies one of the propellants (along with hydrogen) for the main engine; and the emergency egress system landing area (5), to be used in case of a mishap during launch procedures while the astronauts are in the orbiter. The system consists of a slide-wire running from the pad to the emergency landing site; should the need arise, the astronauts would move quickly into a small trolly-like device that would transport them to safety, traveling at high speed along the slidewire.

SPS Hearings

(Continued from last month.)

by Ken McCormick

The next witness to appear was Mr. Garry DeLoss, a professional lobbyist representing the Environmental Policy Center. Mr. Deloss testified that "The Environmental Policy Center opposes the SPS concept and this bill's commitment of funds to SPS technology development because we believe that (1) even if the SPS could be shown to technically feasible, it will never be economically and politically feasible, and, (2) the money which this bill would allocate to SPS technology development instead should be allocated to land-based, decentralized solar energy technologies.

"Several studies have purported to calculate the cost of producing dozens of solar power satellites over a period of many years beginning near the end of this century, and then compare that cost with projected costs for other possible sources of electricity. All of these studies of the economic feasibility of the SPS are flawed in major respects.

"The supposedly objective cost estimates for the SPS are being made by the corporations, NASA space flight centers, consulting firms, and academicians who have a vested interest in encouraging a massive government commitment to SPS. This leads to cost estimates that are mere self-fulfilling prophesies, or what one critic, Dr. John Cummings of the Electric Power Research Institute, calls 'legislating all the answers.' Richard Caputo, who directed a two-year Jet Propulsion Laboratory (JPL) study of the SPS recognized the same pattern of behavior, and characterizes the cost estimates he examined as based on 'assumptions of success' rather than a real data base. The SPS proponents appear to begin by calculating the cost goal which the total SPS system must meet to compete with other energy sources, and then allocate that cost goal among the various subsystems of the SPS. Hence, they tend to reach similar conclusions about the total cost of the SPS based on widely varying estimates about the costs of the sub-systems."

DeLoss also noted several of what he called "diseconomies of scale" in connection with the solar power satellite. First of all, he said, "A utility receiving electricity from an SPS would require a reserve of standby power capacity equal to or greater than the SPS power of five gigawatts" for use as a backup source in the event that power from the satellite should be interrupted without notice.

Second, the commitment of $60 billion required to develop the SPS to a commercial scale is much larger than the commitment to develop other energy sources. "The cost of developing photovoltaic cells for land-based uses to a 10MW scale commercial demonstration powerplant by 1985, for example, will be from 0.2 to 0.4 billion dollars. In other words, the SPS would require 150 to 300 times more R&D dollars just to test its economic feasibility. Even the breeder reactor's proposed development cost of about ten billion dollars is dwarfed by the SPS proposal. The diseconomy of scale inherent in such a large development cost is that it can only be financed by preempting funds that could have been used to develop other energy technologies. In effect, the extremely large development cost requires a commitment in favor of the SPS technology versus competing energy technologies even before the economic feasibility of the SPS is demonstrated.

"A third diseconomy of scale of the SPS is that the projected costs depend on maintaining a specified rate of construction of new satellites. In other words, if electricity demand growth leveled off for a few years, as it did from 1974 to 1976, and consequently, the rate of SPS construction was slowed, costs per unit would rise sharply."

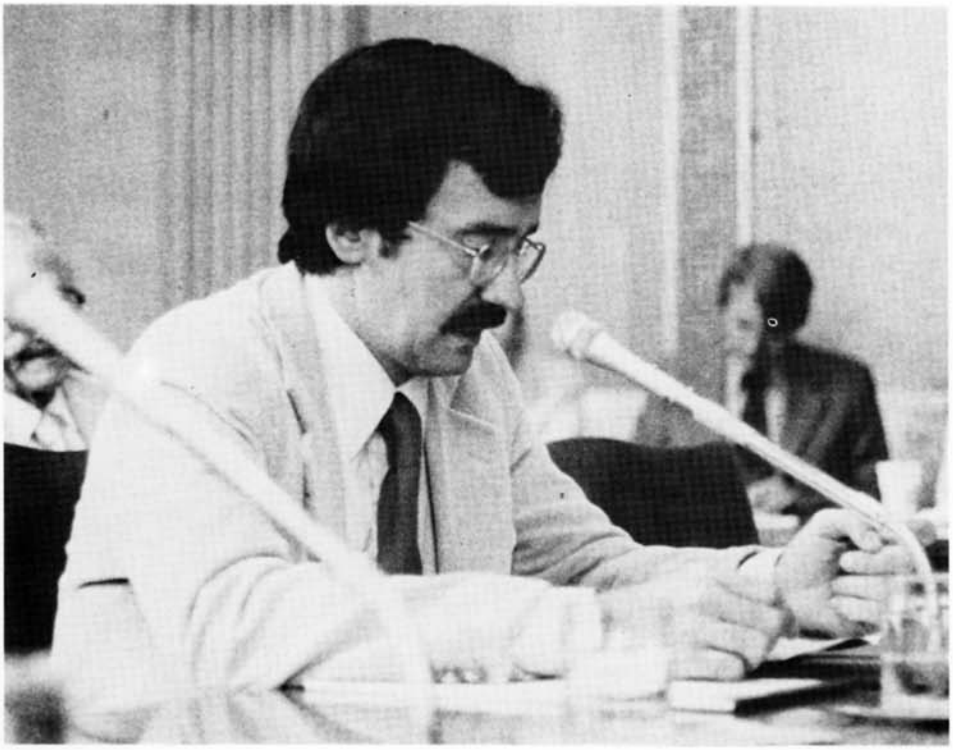
Unexpected variations in demand growth, coupled with the fact of the large power generating capacity of a single SPS, could lead to a mismatch between supply and demand, creating an idle investment for utility ratepayers or shareholders, said Mr. DeLoss.

"A fifth diseconomy of scale of the SPS is that the high cost and high risk of relying on the SPS means that the federal government is likely to be the only entity with the resources and, hence, ability to absorb the risk needed to finance the SPS. Utility companies would be relegated to the role of distributors of SPS power rather than producers."

A sixth "diseconomy of scale" noted was the vulnerability of SPS to attack by a foreign power. Powersats could be attacked in orbit with missiles or gound-based lasers. "Saboteurs," said DeLoss, "could attack the receiving antennae, which would have almost indefensible perimeters of many miles, or the high voltage transmission lines."

DeLoss turned, next, to what he called "the most obvious flaw in the existing studies" on SPS economics, "their failure to adequately consider the lowest cost alternatives to the SPS, which are, first efficiency improvements that will reduce our need for new energy supplies, including new electric generating capacity, and, second, land-based, decentralized solar energy technologies."

With regard to efficiency improvements, DeLoss complained that existing SPS studies "don't reflect the realistic possibility that we will use energy much more efficiently two or three decades from now, especially if resources were commited to energy conservation on the scale proposed for SPS development. No report on SPS economics that I have reviewed includes speculations on how much energy could be saved if the hundreds of billions of dollars proposed for SPS development and deployment were instead spent on improving energy efficiency."


Garry Deloss, testifying against the SPS bill. (Photo courtesy Charles Divine.)

"The SPS proponents prefer to set up the straw man of a centralized solar energy powerplant alternative and then knock it down by claiming high costs for land acquisition, electricity storage, and transmission lines up to 2,000 miles long from solar powerplants concentrated in the Southwestern states. Even the most objective of the SPS studies, the report by JPL, compared the SPS with what its director has described as the 'worst solar terrestrial options,' centralized solar energy powerplants at sites remote from their markets. . . The JPL study concluded that the SPS would cost more than a land-based, centralized solar energy powerplant using a solar thermal process and fossil fuel backup system, and about the same as a centralized photovoltaic solar energy system with a fossil fuel backup system.

"If the SPS costs were compared with decentralized solar electric systems using photovoltaic cells, the SPS would look even worse. Decentralized solar energy systems would be lower cost than centralized solar energy systems used in the JPL study because transmission costs can be eliminated, land acquistion costs can be reduced by using air spaces over rooftops and parking lots, and waste heat can be put to work near the generating site.

"Objections by SPS proponents that electricity storage costs are an insurmountable barrier to lowering the cost of land based solar energy. . .have to be taken with a grain of salt. The people who suggest that major reductions in the cost of electricity storage are not likely are the same people who are extremely optimistic that costs for the various subsystems of the SPS will fall drastically."

DeLoss conceded that SPS might be technically feasible, but pointed to increasing social pressures on the technology of energy production. "In the past," he said, "positive answers to the questions of technical and economic feasibility might have been sufficient to assure the development of a new energy source. But today our society is more crowded, competition for the use of finite resources such as minerals, air, water, and land has increased, and the social and environmental impacts of a new technology are major factors in determining whether it will be developed on a large scale. Hence, in a democratic society, a proposed energy producing technology such as the SPS must be acceptable to the public, or politically feasible, as well as technically and economically feasible."

On the question of the political feasibility of powersats, DeLoss first

Peter Glaser, inventor of the SPS, defending his work. (Photo courtesy Charles Divine.)

pointed out the need for many launches of a heavy-lift launch vehicle (HLLV): "Construction of a single SPS would require 50 to 500 flights of the HLLV at the rate of one to five launches per day. If the dozens of SPS's needed to achieve the claimed economies of scale are to be built, the launches would continue at this rate for decades. Indeed, eventual replacement of worn out SPS's (a 30 year life is predicted) would require such launches into the indefinite future . . . .

"An HLLV being launched would be louder than the less powerful Saturn rocket and an HLLV landing would be much louder than the SST." Because of the noise problem, DeLoss said he doubted that even Cape Canaveral could be an acceptable launch site, due to the fact that "Orlando, Florida and the Disneyworld amusement park are just a few miles away, and the nearby population is growing rapidly."

Another major political barrier to acceptance of SPS by the public which was cited by DeLoss was the public's desire for increased consumer control of the energy supply: "The public enthusiasm for solar energy is based on an interest in decentralized, or dispersed, solar energy systems, not highly centralized systems like the SPS, which must be owned by giant utility companies or the federal government. Solar energy enthusiasts are looking forward to development of solar energy systems scaled for use by individuals, neighborhoods, and communities. . . . Resistance to the SPS will grow as consumers become aware that the larger scale commitment required to make the SPS work would effectively foreclose consumer and public utility commision influence over electricity rates and construction decisions."

The final political obstacle mentioned was the problem of siting receiving antenna areas. DeLoss pointed to the recent controversies over the siting of both nuclear and fossil fuel plants, high voltage powerlines, nuclear waste disposal projects, and the Navy's Project Sanguine, a proposal to bury a huge grid of electric cables for low frequency communication with submerged submarines.

"When I was speaking to a few members of the House, when this bill was progressing the House," said De Loss, "I just happened to contact the office of Congressman Obey, from Northern Wisconsin, and I learned that the congressman got elected to office by running against a 30-year incumbent who supported the siting of Project Sanguine in his district. Congressman Obey opposed the siting, and that won the election for him. So I just wonder, if we're to have a hundred or more of these antenna sites in the country, how many congressmen or senators would want to advocate the siting of maybe three or four of those antennae in his own district.

"SPS proponents are aware of the siting problem. A NASA study could find only 69 potential land sites, and some people have suggested that ocean sites could be used...Perhaps Boeing or the Arthur D. Little company should study the current controversy over a proposal to site nuclear powerplants off the coast of New Jersey,"

Senator Melcher questioned Mr. DeLoss: "It has been stressed by Congressman Flippo and others that there are (congressional) checkpoints to the proposed bill.Do you think there ought to be, or you don't think it's necessary?"

"The checkpoints are only important if you believe that we ought to start down the road along which those checkpoints lie. I think that the existing study, which is approximately half finished, will possibly, if it's altered a little bit in some of those estimates, come up with a negative answer, and the first checkpoint is the end of that study. That's the checkpoint I'm interested in. I think that when we get to the end of that study, we should have an answer that says that this is not a good idea to continue."

"Then you envision the checkpoint (as) being administrative?"

"The checkpoint would be that if the study comes to a negative conclusion, it would be very difficult for the advocates of the SPS to come before the Congress and get authorizations on research and development of SPS."

'What if it's a positive conclusion?"

"Well, then, we'll still fight it . . ."

"You wouldn't object to what Dr. Deutch and Dr. Koomanoff described on their experiment to determine whether or not there's danger from microwaves?", asked Senator Melcher.

Mr DeLoss replied: "We haven't objected to the existing study. In fact, as I said, I think if this study is changed somewhat, and we've already met with (DOE's SPS project management office head) Mr Koomanoff and some of his colleagues to discuss this, that the results of this study will probably be negative."

Senator Melcher persisted: "Well, let's make it a posed question: 'who wants, in their own state, antenna sites?' That doesn't mean much unless you say there is danger from the antenna site. Is that correct?"

"Well, there is at least a *perceived* danger, and that could be as important as a real danger."

Dr. Peter E. Glaser, the originator of the SPS concept, was the final witness to appear before the subcommittee. "We found it difficult, I think," said Dr. Glaser, "to make the linkage in our mind's eye between terrestrial power stations and orbiting solar collectors. Yet, the technology for constructing the latter is at least as well established as several terrestrial power generation methods now under development. There is growing consensus that: The SPS is technologically feasible; the basic research and experimental phases are now past, and there remains what is essentially a challenging engineering task which is well within present capabilities."

Dr. Glaser addressed himself to a few of the objections that had been raised: "I believe I do not have to stand, either before this committee or the public, in explaining my support for solar enetgy of **all** types and applications over the last 25 years. This record speaks for itself.

"I would certainly urge that if funds are allocated (for SPS) that these (funds) do not come out of the solar budget, but, rather, that they come out of the budget for those energy sources which are called 'central power'."

Dr. Glaser recommended a funding level for a five-year technology advancement program that, would equal about 10% of present annual funding for each of the advanced nuclear energy options.

On the issue of microwave biological hazards, Dr. Glaser had this to say: "The microwave transmission system can be designed so that microwave exposure of the public at the perimeter of the receiving antenna site will be 100 times less than the present United States standard for continuous exposure to microwaves and will meet guidelines for microwave exposure adopted by the Eastern European countries."

Dr. Glaser expressed the belief that "thirty years, as was mentioned, is just the beginning of the life of the solar power satellite."

He then pointed to support and interest in SPS which he said exists in the general public, labor unions such as the International Association of Machinists, and foreign countries.

"I have recently visited Europe, and I know that, in Germany, several industries are very interested in it, because they do not have the options that we have. They do not have the type of sunshine that we get in Arizona.

"Furthermore, there is great interest in Japan. Japanese industries realize that their options are very limited....

"I had the opportunity to discuss this with representatives from India. The prime minister of India, so I am told, is greatly interested in solar power satellites. A recent article in the **Christian Science Monitor** quoted an Indian scientist explaining why they are greatly interested in solar power satellites... It would enable them to provide the power they so desperately need to meet the needs of their growing population.

"In Russia, work is progressing. I have met with several Russian representatives at various conferences who are well acquainted with our work."

Dr. Glaser said that he hopes that the scientific data from the ongoing Salyut operations will be freely available. "I think that they are doing a lot of the things that will shed more light on the kinds of things that we will have to do as we attempt to develop solar power satellites."

On the subject of international relations and SPS, Dr. Glaser had this to say: "I was priveleged to attend a conference organized by the American Bar Association . . . (where the) 1967 Space Treaty was being considered by both the NASA delegation and the Soviet delegation. I asked a very specific question: 'If you do construct a solar power satellite, would that fall under the 1967 Space Treaty?' The answer from the Soviet representatives was, 'Yes, it would.'

"The president of the United States...has made it very clear that any object in space should be considered to have the same right of ownership as any object on the surface of the Earth. And so the vulnerability of a solar power satellite is the same as the vulnerability of a ship at sea . . . .

"I believe that the solar power satellite must be considered an object that can be destroyed, but that very few objects now exsist in this world that could not be destroyed. It would be much harder to attack in geosynchronous orbit, and only a few nations would possess such an ability.

"Furthermore, I hold an expectation that solar power satellites would be utilized internationally, on a global basis, with many nations enjoying the benefits....

"I would like to comment on who would own the solar power satellite. The most unlikely owner would be the Boeing Company...I do not see the ownership by any one large company or utility, but rather, similar to the communications satellite, it would be a joint ownership between government, industry, and the public, like Comsat and like Intelsat . . . .

"A flight test program with the space shuttle will provide opportunities for SPS-related experiments to be performed by other nations which may wish to participate in the SPS development program. Such an involvement will set the stage for international cooperation which will be essential to the success of the SPS development program and subsequent commercialization."

"The SPS is obviously an enterprise which would stimulate the development of the nation's capabilities in high technology. As has been noted by Dr. Frank Press: "High technology industries have grown almost three times as fast, increased their productivity twice as fast, expanded their enployment nine times as fast, and at the same time raised their prices only one-sixth as much as low-technology industries.' The SPS is especially remarkable, however, in that its need for high technology is complemented by a need for mass production of very large numbers of repetitive elements (solar cells, microwave power amplifiers, dipole rectifiers, etc.) so that it can provide an important stimulus to employment at the level of skills required for operation of a production line or in the construction industries as well as at the professional engineering level.

"The SPS can also be of very great benefit to the U.S. balance of payments, making our nation again an energy exporter rather than an energy importer. The export trade created by the SPS might involve the sale or lease of power stations in orbit, sale of services such as launch, construction and maintenance for SPS's, or export of microwave power to receiving antennas (perhaps locally built) in other countries....

"Because of its dramatic character and profound implications, the SPS development program can help engender positive attitudes towards the future in a way that could not be expected from, say, a commitment to coal gastification.

"Moreover, a prerequisite for deployment of the SPS is development of a truly economical capability for transportation to orbit and for large-scale construction in space; the possibility therefore arises of other forms of space industrialization and, eventually, of human settlement off Earth.

"The SPS development program will focus development efforts on space processing, fabrication, assembly and maintenance; human habitations in orbit; space transportation efficiency, and the possible uses of extraterrestrial resources, thus setting the stage for achievements which may transcend anything that heretofore has been accomplished by the human species . . . .

"I believe that we are here on the verge of a new evolution—an evolution that can take us into space in ways which we have dreamed about for many years."

Geosynch Best

NASA Marshall and NASA Johnson have now decided that satellite solar power generation can best be accomplished in 24-hour orbit rather than near-earth orbit. The reason is weight. Such large structures in space are subjected to Earth tides, which are 225 times more feeble in the higher orbit and give a weight advantage because less material is needed.

Construction of such satellites will require a high-orbit work force of 500 and a completely reusable space freighter.

Facts and Fallacies of Space Warfare

by James Oberg

This article is not an advocacy of any particular space warfare system, nor an indication of the existence of any particular system. Any opinions expressed are purely those of the author.

Few space images are as spectacular as those of space combat, al la **Star Wars** or **Star Trek**. Death rays and photon torpedoes zap across the vacuum of deep space, seeking targets. Stricken spaceships tumble from the sky in flames.

Closer to our modern world, newspaper headlines scream about Soviet killer satellites. "Seize the high ground," cry the traditionalist military thinkers, and surely nothing is higher than space. Critics denounce civilian space projects as secret attempts by the Pentagon to build space weapons with which to threaten the world below. And H-bombs in orbit could become a real Damocles Sword hanging over humanity's head.

The vulnerability of giant space power satellites to enemy action has become another key argument in the arsenal of those who oppose such systems. They paint grim scenarios where America's electricity supply is crippled by an enemy's space hand grenade.

As usual with highly technical questions of space flight, most of the printed material about 'space war' is garbage. Basic concepts of astrodynamics and space operations are ignored by ignorant but attention-getting spokespeople of a dozen different clamoring pressure groups.

What are the facts and fictions of war in space? What are the basic operational considerations which make many of the most common ideas about space war utterly impossible? And if military operations ever are conducted in space, what form might they take?

First off, readers must realize that it is impossible to "shoot down" a space satellite. It cannot be done. No way, no matter how big the bomb or how fast the anti-satellite missile or how devastating the radiation beam.

Here's why: space satellites are kept in orbit not by virtue of their wings or their rockets or their solar power panels, but purely by virtue of their momentum, or their velocity through space. Over a matter of days or weeks, most satellites are little slowed by the very thin air drag at orbital altitudes.

So if a satellite is hit by a weapon, the spacecraft may be crippled or punched full of holes or broken into pieces, but the debris continues in orbit. It remains in space.

But military tacticians do not need to 'shoot a satellite down' to be successful in their military objectives. They can cripple it, confuse it, or even kidnap it. They can cut its communication links with the Earth. They can destroy the effectiveness of its equipment, or they can kill the crew or destroy the intelligence of the onboard control computers.

How? Space is very different from Earth in this regard, and two of the major distinctive features are speed and vacuum. Both make major changes in 'common sense' military actions.

Take speed, for example. The closing rates of enemy spacecraft can usually be measured in the tens of thousands of miles per hour, maybe up to ten miles per second. Obviously there is no reaction time for a pushbutton response to the 'whites of their eyes'. Weapons are deployed seconds in advance, at a range of hundreds of miles. Even the tremendous velocities of dead metal can cause terrible damage if it hits another vehicle, so explosive warheads are hardly necessary. Hot metal could be even more deadly.

One simple anti-satellite weapon considered in the 1960's was a cheap solid-fuel rocket like a Scout or an Aerobee, which simply tossed a few hundred pounds of ordinary sand and gravel up into the path of an on-coming satellite. Zip zap! the target satellite is peppered by celestial buckshot at five miles per second. Perhaps holes are punched in its skin. At the very least, its windows and solar panels are sandblasted to ruin.

Setting off a high-explosive charge nearby a space target will, of course, have no direct effect, because there is no air to conduct the concussion; the only possible damage is through shrapnel, and that is why the Soviet anti-satellite system seems to call for the explosion of the **hunter** satellite, while the target satellite continues in orbit, slowly tumbling and dead. Evidently the Russians have built a cosmic "Claymore Mine", an explosive device which directs the majority of its fragment grenade shards in a set direction. Woe to the spacecraft in the swath of these human-made meteorites!

The alternative to impact weapons are radiation weapons, and here is where the vacuum of space becomes important. There are no clouds, and rays of energy can cross thousands of miles, spreading out only as much as the generating optics of the weapon allow.

Lasers have been called 'death rays', but such a use within Earth's atmosphere may be marginal. In space, a laser system powered by giant electric generators or by chemical reactions could beam energy across twenty thousand miles, to melt an enemy vehicle, or at least blind its cameras and the eyes of its pilots, or maybe nudge it off course.

More insidious than lasers is the radiation generated by nuclear detonation. On Earth, many of the wavelengths of radiation are absorbed in the atmosphere, but in space they fly out to infinity. Take X-rays, for example, which on Earth are absorbed by the first few hundred feet of air around the detonation, forming the characteristic super-heated fireball. In space there is no fireball, but the X-rays zap directly into the walls of the target spacecraft.

When gigantic bursts of X-rays hit a solid object, their energy is instantly absorbed, causing the outer skin to expand suddenly. This expansion is slight but sharp, and sets off a hypersonic shock wave which propagates through the skin of the vehicle to the inner wall. This energy of the shock wave does not peacefully transfer itself to the air inside, but instead tears off fragments of the inner wall (it's called 'spallation') and shoots these fragments into the interior of the spacecraft at supersonic speed. The whole wall facing the nuclear burst thus becomes a giant shotgun shell, tearing the guts out of any electronics (and humans) inside.

Not far behind the X-rays are the neutrons and other particles. They could pass harmlessly through the soft body of an astronaut, but for one catch. Before they reach the tissues of the astronaut, they strike metal atoms in the skin of the spaceship, and knock off atomic fragments which go careening through space. And these 'secondary' particles are not at all harmless when they pierce a human body.

Depending on energy dosage, the astronauts or cosmonauts might receive survivable doses (measured in **rems**, either whole-body dose or skin dose), or might receive second or third degree skin burns, or might be instantly instantly incapacitated like a spider dropped on a hot skillet. It depends on range and power.

Naturally, too, there is the thermal pulse and visible light pulse of the nuclear detonation. But compared to the damage of the earlier effects, they are not too important.

Lastly is yet another devasting effect of space bursts of nuclear weapons. It is called "electro-magnetic pulse", or EMP.

We've all heard bursts of static on radios and TVs when a lightning bolt flashes nearby. That's EMP, but on a tremendously tinier scale than that associated with nuclear detonations in space.

The magnetic pulse near (that is, within a few tens of miles) a large thermonuclear blast is so powerful that it induces electric power surges in every metal conductor within reach. Walls, wires, pipes, teeth braces, everything develops a high voltage which burns out electric circuits and sparks across gaps, setting off fires and filling the air with the smell of ozone.

How can a spacecraft defend itself against such vicious energies?

Well, in a moment we'll discuss the first, best defense: hide. If they can't find you they can't blast you.

But there is also a range of active defenses, and again, they are based on the two unique features of space: high speeds and hard vacuum. They can be used for defense as well as offense.

First, an enemy weapon can be zapped itself before it gets to bite, by hitting it with sand clouds launched a few moments earler. Particularly vulnerable are nuclear weapons, which are complex devices prone to glitches and easily damaged. So hit first — or set up barriers of "space sand traps".

How about beam weapons? They work in space because it's a vacuum. The defending ship might deploy a gas cloud between itself and the attacker to absorb much of the beam's energy. Lasers can be counteracted in space with highly reflecting three-corner mirrors which beam the radiation back in precisely the direction from whence it came, zapping the attacking laser. "Hoist on its own petard" is an expression rooted in just such a parallel tactic from the wars of the Middle Ages (a petard was an explosive charge).

"Even if Babylon could climb to the sky and build a strong fortress there, I would still send people there to destroy it . . ." — Jehova makes first space war threat, 566 BC (**Jeremiah** 51:53).

Protective measures can be taken against some effects of nuclear blasts. Interior walls can be lined with materials such as cork to contain the 'spallation' shotgun shell effect. Electronic circuits can be shielded in 'EMP cages' which divert the electromagnetic pulses around the circuits; the circuits can also be built with surge resistors to contain less-than-lethal EMP pulses. And crews can be protected to an extent by appropriate shielding, such as a tiny "storm cellar" in the heart of the ship, perhaps surrounded with the dense fuel and water tanks.

But the best tactic is to avoid fighting at all, and to elude the senses of the hunters. Space is so vast and our ships are so small . . . .

Powerful Earth-based radars scan orbits near the Earth and can, with effort and ingenuity, track objects out to about two thousand miles. The limiting factor in using radar is that the outgoing beam diminishes by the famous "inverse square law", and the returning echo **also** diminishes by another inverse square. This means that an object only twice as far away will return an echo **sixteen** times (two squared and squared again) as weak.

Space-based radars will for the forseeable future be much weaker, with ranges of less than a few hundred miles for combat spacecraft detection. Besides, blasting nearby space with a questing wave of energy is the loudest way to attract attention to oneself, attention of other predators lurking silently nearby ("near", say, two hundred miles, closing at two miles per second—you have less than two minutes to live or die).

One trick to avoid these problems is to emit the detection beam from a powerful and protected Earth-based site, and let the space-based fighter craft listen for the echo. In space, giant receiving antennas can be deployed, hundreds of yards across, from a spacecraft, to receive the tiny whispers which betray the locations **and** velocities (via Doppler shift) of silent neighbors who would not even realize they had been detected.

An alternative sensor is only an extension of our first space exploratory sense: sight. Powerful telescope cameras on mountain tops (or, later, in low earth orbit) could watch for spacecraft tens of thousands of miles away.

Neither optical nor radar sensors help much when the prey releases decoys, corner reflectors for radar and balloons to fool the probing telescopes. So for each move there is a counter-move, and a counter-counter-move . . . as always.

Another way of detecting spacecraft is with ion sensors to sniff out their expended propellants. The background readings might disguise any but the most gross enemy rocket firings, but any vehicle attempting a surreptitious rendezvous **must** fire braking rockets which could scatter a tell-tale hail of ions ahead of the hunter, alerting a keen-nosed quarry.

Yet another way spacecraft betray their presence is via their communication activity, responding to commands and advice from earth, or other space-based colleagues. One way to avoid this is to communicate along thin low-power laser beams aimed directly at the calculated position of the target. The chance of interception is very small, as is the chance of detection . . .

Unless, of course, the hunter sows a cloud of dust across the spaces within which the quarry is suspected to be hiding, and sensitive infra-red sensors wait to see the laser communications beam unsuspectingly light up a line through this cloud, pointing its accusing finger both to the secret sender and the secret receiver . . .

Unless, of course, the beam was bounced off a mirror left floating in space by the foxy quarry, suspecting such a trap. The hunters find only the mirror while the fox flees safely ten million miles away.

We cannot yet speak of millions of miles, since space combat of the next few decades would happen in some rather restricted arenas. Space, while unmarked and boundless, has certain dynamic regions of varying importance. They are called Low Earth Orbit (or LEO), Geo-Synchronous Orbit (GEO, and its half cousin SEMI-GEO), and Cislunar Space (CLS), as well as Lunar Space and Trans-Lunar Space (TLS).

LEO is within a few thousand miles of Earth, in which earth-based sensors and weapons can assist the spacecraft, and in which spacecraft can hide from others (and from blast effects) by flying in close to the Earth and ducking over the horizon.

GEO is a band around the equator, some twenty two thousand miles high, at which objects orbit at the same speed as the turning Earth below. It is a valuable ring of space real estate, now being filled with communications and warning satellites, and future home of power satellites.

Semi-GEO orbits are only twelve hours long, or twice per day, rising out to GEO altitude at high point but falling back to only a few hundred miles above the atmosphere at low point. It is a favorite orbit for many Soviet and American military satellites, as the spacecraft alternately swings high over North America, then twelve hours later high over Eurasia.

Military spacecraft are even farther ranging, even today. VELA monitors skim out sixty thousand miles to watch for secret nuclear blasts taking place anywhere in the solar system, even behind the moon.

War in space, or at least combat in space, is a chilling possibility of the near future. Some observers find the concept abhorrent, hoping to maintain space a zone of peace. Others would welcome such a development, emphasizing as it would high technology devices in which the United States excels. Further, these latter observers claim, where better to fight a future war than in bleak emptiness far from any civilians?

But if history is any lesson, concepts and notions of combat seem to lag a generation behind. So it seems to be happening with the idea of 'space war', which teems with modern misinformation and misconceptions.

A Space Solar Power Satellite (SSPS) presents unique military problems. It is too big to hide, but on the other hand it is too high for anyone to sneak up on it from behind the Earth's horizon. It has a tremendous potential of power for both detection (via radar) and defense (via IR lasers).

Its size is so large that little short of a megaton-sized nuclear detonation is likely to harm it. Notions that it could secretly be 'killed' by some Soviet weapon system, in such a way that the Earth would not be able to tell that it had been attacked and had not been the victim of a natural catastrophe, are extremely far fetched. Sandblasting of the solar cells might be marginally effective over the long run, but this could not occur instantaneously nor could it be done in secret.

In the stable 24-hour orbit over the equator, the SSPS could deploy its own defense systems as needed, including 'space ramparts' of sand or pellets. This material, drifting in nearby orbits, would not be dangerous to the SSPS or to visiting spacecraft due to the low speed of their rendezvous orbits, nor would the particles interfere with light or microwave emissions. But they could destroy any fast-moving attack satellites which ran into them.

The electrical energy could power radar pulses which could track attacker-sized vehicles tens of thousands of miles away, thus giving hours of warning. For protection, a high-energy laser beam could be used, but a laser beam whose frequency was deliberately selected so as to be absorbed completely in air. Thus it would by its very structure not be a threat to any ground target.

The radiation protection needed normally for the onboard personnel (due to the high altitude above the magnetosphere, open to direct solar radiation) would add extra protection in the event of hostile action.

So the SSPS is far from a helpless, vulnerable space target, as some critics would like us to imagine. It can take punishment, cannot be shot down, and can detect and swat enemy vehicles more easily than they can take action against it.

One last example: who has not heard of the notion of putting "bombs in orbit", to threaten the Earth below with instant annihilation?

The idea is absurd. It's not that it would not be a friendly thing to do: it doesn't make sense and it can't be done at all effectively.

Here's why: as the weapon orbits the earth, it passes over locations below—but at most, only twice a day, and often many hundreds of miles east or west of a potential target. In the event of war it could take many hours before it could be lined up for attack. During that time, far simpler devices on ships at sea or launched from high-flying jet aircraft could cripple it.

And of course, while the bombs are orbiting, there is always the chance of failure, or capture, or secret disabling by covert attacks one by one. And the potential target nations always know where the bombs are and when it would be possible for them to be a threat, and when not.

Missiles in silos or submarines are more accurate, better protected, and can reach targets within half an hour, simultaneously. From a military point of view, they make far more sense.

The logic of space flight has had only twenty years to sink into the consciousness of the population. Its application to military activities is still veiled in mystery and mistakes. Wars seem to spring from miscalculations and bad estimates, of which there is an overabundance today. A summary of the 'facts of space war' will help keep space war forever a figment of our imaginations.

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DOE Appoints New Spokesmen In Four Regions

New DOE representatives have been named for Region I (Boston), Region II (New York), Region V (Chicago), and Region IX (San Francisco).

As chief spokesmen for the Department, the four will administer the Department's regional programs and will provide overall direction for DOE's regional dealings with the public, state and local officials, business and labor and others concerned with energy policy and planning.

Harold J. Keohane, 40, chairman of the Massachusetts Department of Public Utilities has been named DOE chief for Region I which includes Maine, New Hampshire, Vermont, Massachusetts, Connecticut and Rhode Island.

Robert A. Low, 58, will head up DOE activities for Region II which includes New York and New Jersey. He was formerly head of New York City's Environmental Protection Administration and director of the city's energy office.

The Manager of DOE's Chicago Operations, Robert H. Bauer, 50, will be DOE's chief spokesman in the states of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. He will continue his role as Chicago Operations Manager, a post he has held since 1972.

William C. Arntz, 52, who has been Acting Regional Representative for Region IX since DOE was activated, heads up the area of Arizona, California, Hawaii and Nevada. He was Regional Administrator for the former Federal Energy Administration from 1973 until DOE was activated.

Solar Energy Calendar

23-25 OCT 1978: Los Angeles, CA. Solar Energy, seminar sponsored by New York University's School of Continuing Education. Contact: New York Management Center, Inc. 360 Lexington Ave., New York, NY 10017 (212) 953-7272.

13-15 NOV 1978: New York, NY. Solar Energy, seminar sponsored by New York University's School of Continuing Education. Contact: New York Management Center, Inc., 360 Lexington Ave., New York, NY 10017 (212) 953-7272.

15-16 NOV 1978: Miami Beach, FL. Solar Energy Applications, conference sponsored by the American Institute of Chemical Engineers, 345 E. 47th Street, New York, NY 10017 (212) 644-7526.

BIBLIOGRAPHY UPDATE

by Conrad Schneiker

"Astronaut Special Issue"
Space World, July 1978

A series of articles on who's going to fly in the shuttle and how they are (and will be) selected and trained.

"Space Colony Debate Issue"
Space World, June 1978

A collection of articles presenting pro and con views on space colonization, reminiscent of the "debates" printed in the Coevolution Quarterly Space Colony book.

Looking Beyond The Space Shuttle
Dave Dooling
Spaceflight, October 1977

Reports on a study of single-stage-to-orbit vehicles. This study was recently completed at NASA's Langley Research Center. The study found the use of dual-fuel engines may make possible single-stage-to-orbit launch vehicles that are little bigger than the space shuttle and weigh far less. This would result in greatly reduced launch costs.

Space Factories In 1977 -- Part 1
Dave Dooling
Spaceflight, October 1977

Gives brief history of space processing experiments, listing the more interesting results. Planned and proposed developments in space transportation and space habitation that may lead to a space factory are discussed.

"Achromatic Trajectories and Lunar Material Transport For Space Colonization", T.A. Heppenheimer
Journal of Spacecraft And Rockets,
May/June 1978

Derives trajectories for launching mass from the moon to L-2. The discovery of trajectories tending to be relatively insensitive to launch velocity errors is reported. Optimal lunar mass driver siting and aim direction is discussed. Finally the equations describing mass catcher motion in the vicinity of L-2 are presented.

"Soviet Shuttle Tested"
"Soviet Update"
National Space Institute Newsletter,
June 1978

Very short notes claiming the Soviets have tested a shuttle (kosmolyot) and are also considering a lunar polar orbiter.

"Will Iceland Sell Heat Via Microwaves?"
Microwave System News, May, 1978

Iceland could become "The geothermal Middle East of the North Atlantic" if studies in progress there lead to a geostationery power relay satellite system. Using Iceland's abundant geothermal energy, the system could relay energy to the eastern coast of North America and most of South America, Africa, and Western Europe. Among other things, Iceland's incidence of earth quakes has kept venture capitalists away for the time being.

"Space Junk Menance"
Richard F. Dempewolff
Popular Mechanics, Aug. 1978

Half of some 10,500 objects launched since 1957 have re-entered — falling in backyards, crashing into highways, striking ships and even killing a cow. It may get to the point where advanced SST's need special radars and computers to avoid junk in decaying orbits. This article also discusses the SKYLAB menance, noting the NASA-NORAD discrepancies in predicted re-entry dates, but overlooking NASA's well-know political motivations for issueing a bad prediction. DOD's plans for complete tracking coverage of the skies to 20,000 nautical miles and beyond are given brief mention.

"A Mass-Catcher For Large-Scale Lunar Material Transport"
T.A. Heppenheimer
Journal of Spacecraft and Rockets, July-August, 1978

This technical report demonstrates the possibility of positioning the lunar mass catcher across achromatic trajectories, yet maintaining modest propellent requirements and low impact velocities. More good, solid research supporting the "high frontier" concept; more significantly, it was not supported by NASA, but by a West German foundation.

"Low Cost Transportation is the Key to Space"
Tom Broz
Foundation Report, August 1978

Reports design studies on low cost launch vehicles conducted by Foundation, Inc. These vehicles, had they been built and lived up to their expectations, would have cost much less to build and operate than the Space Shuttle. The designs tried to maximize off-the-shelf technology and built on the pioneering work of Phil Bono, the McDonell-Douglas engineer who advanced single-stage shuttles in the 1960's. This kind of work done during the last decade is now being duplicated by aeorspace and government studies.

Air Et Cosmos, March 11, 1978

Contains an interesting collection of articles on the European Space Agency's Ariane launcher. (We're reviewing a reprint with English translations). The news: immediate construction of 5 Ariane launchers plus one backup has been approved by ESA. Four test launchers are already in production. The Ariane is aimed at the geostationery market, competing head-on with the space shuttle for uncommitted customers such as Canada and INTELSAT. The article "Ariane vs. Shuttle: The State of Competition" compares the respective launches on numerious points and the shuttle comes out the loser. Where the shuttle does have advantages, they arouse little interest among potential users. In fairness to the shuttle, the author notes, it will be useful for developing human presence in space.

"Possibility of Utilizing Higher Plants in a Life-Support System on the Moon"
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina, Vol. 12, No. 3 (May-June), 1978, pp. 63-67
by Terskov, I. A., G.M. Lisovskiy, S.A. Ushakova, O. V. Parshina, L. P. Moiseyenko

The possibility is examined for the repeated interruption of plant vegetation by long-term darkness corresponding to the "night" on the Moon. This may prove useful for incorporating a unit of higher plants into a life-support system on lunar bases in the event of using the sun as an illumination source. To this end, cultures of vegetables (Bordeaux beets, Petrovskaya turnips, Chantanet carrots, dill, and Virovskiy white radish) and wheat (Sonora variety) were cultivated during a "lunar" photoperiod, i.e., the light and dark periods equal 15 terrestrial days. The tests convincingly showed the basic possibility of obtaining traditional plant products under conditions of the "lunar" photoperiod. It was also proven possible to use grain from wheat grown during the "lunar" photoperiod as seed material for further cultivation of these plants during this photoperiod. [Author's Abstract]

Spinoff

Scientists working for America's aerospace program have made many far-reaching technological discoveries and advances in the course of their efforts to provide vehicles for space exploration. Only now, as their voluminous findings are examined for possible reapplication to other technologies, is the full impact of their pioneering research being widely recognized. These reapplications or "spinoffs" are beginning to assume major proportions, touching most of our lives, directly or indirectly, every day.

Spinoff 1978 selcts, from thousands of examples, those technology transfers representing important advances of significant public benefit, discussing their new-found uses and their development from the original aerospace applications. These spinoffs range from designs for more efficient aircraft to increased-resonance guitars, from capsize-proof life rafts to burglar alarms, from body-building equipment to a jet propulsion system for boats, from foam filters for cars to five-year flashlights, from a device for extending lightbulb life to "foil" wall paper, from heat resistant paint to metallized food packaging, and many, many more. Copiously illustrated with color photographs, **Spinoff 1978** is an an attractive and fascinating appreciation of the many truly "space age" aspects of our contemporary lifestlyle. 178. 124 p. il.
NAS 1.1/4:978
S/N 033-000-00712-4 $3.25

NASA Tech House

Tech House (Technology Utilization House) consumes only about one-third the electricity and one-half the water of comparably-sized homes. It incorporates solar heating, central air conditioning, a super efficient fireplace, roll-down thermal shutters, a complete interior and exterior intruder alarm system, fire resistant construction, a waste water recycler, evergency power-failure lights, three bedrooms, two bathrooms, and a garage into a design that can be built for approximately $50,000 (in 1977 dollars).

NASA constructed and is currently evaluating Tech House in order to demonstrate the extent to which some of the space program's many scientific breakthroughs can aid in the construction of more efficient, more comfortable, safer, and less expensive homes in the near future. This booklet discusses and illustrates the many innovative features of Tech House in non-technical language and examines the promise they hold for all homeowners, present and prospective. 1977. 19 p. il.
NAS 1.19:149
S/N 033-000-00704-3 $1.10

Apollo Expeditions to the Moon

A dazzling color book about the entire 15-year Apollo space program, written by 18 key members of the team that successfully planned and carried out the enormous national effort to land Americans on the moon. Its 15 chapters tell the dramatic story of what are perhaps the most exciting and challenging scientific voyages in modern history, voyages that symbolize the triumph of mankind and technology over seemingly impossible odds.

The 18 contributors include current and former key NASA officials, astronauts, engineers, and scientists. Among the famous names are Vernher Von Braun, Buzz Aldrin, Michael Collins, Charles Conrad, Alan Shepard, James Lovell and Chris Kraft. Each describes his role in helping to make the complex Apollo missions successful, providing broad insight into the US civilian space program from its inception to the present. These accounts are accompanied by full color photos that appear on almost every page, some of which have rarely been seen by the public.

Bringing together the momentous events that were witnessed by millions and the little-known and unreported experiences of the people responsible for them in a single detailed pictorial volume, **Apollo Expeditions to the Moon** is one of the finest and most complete space-exploration accounts ever published. Available from the U.S. Government Printing Office, Washington, DC 20402, cloth cover, $8.90.

Hearings Reports

Senator Howard W. Cannon (D-Nev.), Chairman of the Senate Committee on Commerce, Science and Transportation, announced the availability of the following hearings in the area of science, technology and space:

—Nasa Authorization for Fiscal Year 1979, parts 1, 2, and 3, February 21, 22, and 28, March 1, 7, 8, and 16, Serial No. 95-86 (Part 4, Index, to be printed at a later date).

—Oversight of Science and Technology Policy, Parts 1 and 2, February 10, 14, and April 26, 1978, Serial No. 95-77.

—Export Policy, Joint hearing between Committee on Banking, Housing and Urban Affairs and Committee on Commerce, Science and Transportation, Part 7, Oversight on U.S. High Technology Exports, May 16, 1978.

—Committee Print — Recombinant DNA Research and its Applications, Oversight report, together with minority views, August 1978.

—Authorization of the Standard Reference Data Act and Review of the National Bureau of Standards, February 15 and April 6, 1978, Serial No. 95-72.

—Nuclear Waste Disposal and Utilization, March 31, 1978, Serial No. 95-92.

A limited supply of these hearings is available. Requests will be filled in the order received. Interested persons should send a self-addressed mailing label to the Senate Committee on Commerce, Science and Transportation, Subcommittee on Science, Technology and Space, Room 5202, Dirksen Senate Office Bldg., Washington, D.C. 20510. Please specify which of the above publications you are requesting.

Terraforming

"Terraforming — the conversion of dead planets, asteroids, and moons into habitable biospheres". That definition may be familiar to SF readers and other futurists, but it's not in any dictionary. Soon, however, **Terraforming** will be the title of a book I'm writing. Science Fiction ideas, climate modication, planetology, energy and materials resources, and clever tricks to convert Mars into another Imperial Valley and Venus into an African savannah will be discussed, as well as why, who, when, and how.

I wrote a long lead article on terraforming in the May issue of **Astronomy**. Now the material to be published must be increased ten-fold.

So I'm asking for help: references to SF stories from Stapledon to Anderson to Benford to Clarke; weather and climate modification clippings; publishable ideas, speculations, critiques (all properly credited). Where does terraforming tie in with SPACE COLONIES, via competition or complement? Please write me with suggestions.

James Oberg
Rt. 2 Box 1813
Dickinson, TX 77539

Energy Progress?

A small step for man, a small step for energy. Undaunted by conference committee battles, the House Energy and Power Subcommittee staff floated some fuel-saving compromises of their own last week. Among the suggestions outlined in a memo: Postpone going metric until "a three-foot meter can be developed," thereby reducing "nationwide, the commuting distance by almost 10 percent"; Lower the boiling point of water so that it takes less energy to run the turbines in powerplants.

"The Future United States Space Program"

by Carolyn Henson

October 30 through November 2 "The Future United States Space Program" will attempt to top "The Industrialization of Space" as the largest, most exciting space conference ever held.

The conference kicks off Monday afternoon with two concurrent sessions: "Space: the Arena for Change" and "Optimization and Numerical Methods". The former features a talk by Chuck Hewitt, executive director of the National Space Institute, and three talks which examine opportunities for students and small-scale investigators to use the shuttle. The latter is intended for people whose work causes them to dream about Riemann surfaces.

"Social Aspects of Space" and "Space Guidance" run concurrently the second half of the afternoon. The former features talks on "The Possible Socio-Politico Nature of Early Space Colonies" where sociologist Robert McWilliams examines a number of isolated Earth communities and draws parallels to space habitats; "Constructing Space Communities: A Critical Look at the Paradigms" where sociologist B.J. Bluth considers utopian v.s. facilitative organizational development v.s. synergistic organizational development, drawing from her experience with a summer-long course she organized on space colonies. In "Space War" Soviet space program expert James Oberg reveals the facts and fallacies of space war; "Lunar Base Habitat Explorations Design Study" details a complete habitat design by a twelve person team at the Lunar and Planetary Sciences Institute. "Financial/Management Scenarios for a Solar Power Satellite Program", will be presented by a team from Science Applications. They reveal the results of their study for the Department of Energy. (Chris Basler fans will find this talk to be a valuable update on his "Staging Company" concept.) "Developing Closed Life Support Systems for Large Space Habitats", by agronomist John Phillips and anthropologist/plant ecologist Annita Harlan will show that research under way at the Environmental Research Lab not only promises a psychologically satisfying diet for space settlers; it may also go a long way towards solving the problem of hunger on Earth.

Tuesday begins with "Projected Space Applications" where researchers cover solar power satellites, possible human exploration of Mars, and laser aircraft propulsion. "Frontiers of Space Law" runs concurrently, featuring papers on communications satellites, the shuttle, remote sensing, solar power satellites, and military use of space. Later in the morning, "Economics" covers the approaches whereby cost of space activities is determined.

Tuesday afternoon "Projected Space Applications II" covers the defense program, interactions with Congress, technology transfer, Earth resources programs, and the role of non-aerospace companies. The other afternoon session is "Space Medicine". A highlight of the session is SPS inventor Peter Glaser's paper on "Health Maintenance and Health Surveillance Considerations for an SPS Space Construction Community".

Wednesday begins with "Future Programs and Prospects I", covering communications, the shuttle, Earth observation and future programs; and continues in the afternoon as "Future Programs and Prospects II".

Thursday morning has sessions on "Space Science Programs" and "Engineering in the 21st Century".

Other conference events include an awards luncheon Tuesday and a banquet Wednesday featuring House Science and Technology Committee chairman Olin ("Tiger") Teague.

This conference is the 25th annual meeting of the American Astronautical Society. Cosponsors are the American Institute of Aeronautics and Astronautics, the Aerospace Medical Association, Deutsche Gesellshaft fur Luftunde Raumfahrt eV (the German space agency), the Federation for the Advancement of Students in Science and Technology, International Institute of Space Law, L-5 Society, National Energy Resources Organization, and Science Fiction Writers of America.

Advance Conference Registration

TO: The American Astronautical Society
1830 NASA Road 1 LEC Mail Code D-01
Houston, Texas 77058

ADVANCE REGISTRATION:

(Members)	☐	$20.00 one day	(Student)	☐	$ 5.00 one day
	☐	$50.00 four days		☐	$10.00 four days
(Non-members)	☐	$25.00 one day	(Banquet)	☐	$15.00
	☐	$70.00 four days	(Awards Luncheon)	☐	$10.00

NAME ______________________ POSITION ______________ DEPT. ________

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ADDRESS ____

(Street) (City) (State-Zip)

Inside the L-5 Society

Space Day

In the last few years there has been a low-keyed effort to have July 20, the anniversary of the Apollo 11 moon landing, proclaimed a national holiday. Up to the present, however, we know of only four states: California, Massachusetts, Alabama and Texas, which have had any sort of space awareness days.

A Space Awareness Day for Massachusetts was one of the goals of S.P.A.C.E., a Boston-based group. Although momentum in achieving this goal was slow in developing, the effort eventually required a minimum of time and was surprisingly easy.

We were initially operating under one major misconception: that legislative action would be required to have a holiday of this nature enacted. However, states typically proclaim a number of such special days: Dairy Day, Indian Heritage Day, etc. There was even a Saxophone Day proclaimed this year in Massachusetts. It is apparently customary for governors to make such proclamations, and it is within the discretionary powers of governors to do so without legislative involvement.

Finding this out disabused us of the false information that our efforts could only be undertaken with the help of a lawyer. The sum total of my efforts to have July 20 proclaimed Massachusetts Space Awareness Day amounted to the following:

1) In late May I approached the private secretary of Massachusetts' Governor, Michael Dukakis. This required no appointment, and in the short space of ten minutes I had explained my intentions, informed her that a local organization was sponsoring it, and received the news that the Governor routinely signed such proclamations. The personal secretary gave me a copy of a recent proclamation, Massachusetts Indian Heritage Day, and told me to submit a draft in the same form.
2) In early June I submitted the proclamation to the Governor's office and was told that we would be contacted within ten days as to the date that the Governor would sign it.
3) Two weeks later we were notified that the proclamation would be signed on June 26 at 11 AM.
4) On June 26 approximately 12 members of both S.P.A.C.E. and Boston L-5 collected in Governor Dukakis' outer office. In attendance were former astronaut Philip Chapman, Kevin Fine, Mark Hopkins, Wade Nivison, Marcia Allen, Robert Nichols (Director of Boston L-5), Beverly Bugos, Kathleen Prestwood, Bill Rudow, Frank Crehan, Ron Russell and myself. The signing, with posing for publicity photographs, took no longer than 10 minutes.

If all of this sounds easy, it's because it was. L-5 and S.P.A.C.E. members in other states should adopt as a goal for the upcoming year getting the governors of their own states to proclaim July 20 a state holiday. Perhaps, if we can get each state to proclaim a Space Awareness Day, it will be easy to make July 20 a permanent national holiday.

We are including a copy of the proclamation, for members in other states to use as a model .

Whereas:

The achievements in space by many nations have enriched the lives of Earth's inhabitants, from expanded employment in many fields and through the development in many fields and through the development of new technologies; and

Whereas:

The Apollo lunar missions, and present and future activities in space demonstrate that our planet is part of a vast and expanding system, rich in opportunities, a "High Frontier" which will renew the spiritual qualities that built the United States; and

Whereas:

Many citizens and industries of Massachusetts have participated in and contributed greatly to these historic activities in space; and

Whereas:

July 20 is the anniversary of the Apollo 11 lunar landing mission, when two Americans became the first men of our planet to walk on another world, saying, "We came in peace for all Mankind,"

Now, therefore, I Michael S. Dukakis, Governor of the Commonwealth of Massachusetts, in accordance with Chapter 124 of the Acts of 1972, do

The signing of the Space Day proclamation: Massachusetts Governor Michael Dukakis is seated at the desk. Behind him, from left to right, are W. Jefferson, B. Bugos, K. Prestwood, M. Allen, M. Hopkins, R. Nichols, R. Russell, W. Nivison, P. Chapman, F. Crehan, K. Fine, W. Rudow.

hereby proclaim that July 20 shall be known as Massachusetts Space Awareness Day, and urge the citizens of the Commonwealth to take cognizance of this event and to participate fittingly in its observance. —*Wayne Jefferson*

L-5 Chapters

Ashland L-5
Box 1420
Randolph-Macon College
Ashland, VA 23005

Austin L-5
P.O. Box 8213
Austin, TX 78712

Bay Area L-5
c/o David Brandt-Erichsen
814 Miramar Ave.
Berkeley, CA 94707
(415) 526-9346 or (415) 645-5990
(Has newsletter)

Boston L-5
c/o Eric Drexler
WI-518A MIT
Cambridge, MA 02139

Fresno L-5
c/o Gale Smith
36874 Cressman Road
Auberry, CA 93602

Genesee L-5
c/o Wendy or Bruce Voris
78 Lattimore Rd.
Rochester, NY 14620
716/461-5620

Houston L-5
c/o Larry Friesen
502 S. Austin No. 17
Webster, TX 77598

Jacksonville L-5
c/o Penny Stombock
Star Route 1 Box 1208
Yulee, FL 32097

Maryland Alliance for Space Colonization
c/o Gary Barnhard
4323 East-West Highway
Bethesda, MD 20742
(Has Newsletter)

Melbourne L-5
c/o Mike Dalton
650 E. Dixon Blvd. No. 3C
Cocoa, FL 32922

Michigan L-5
Box 126
Michigan Union
Ann Arbor, MI 48109
(Has newsletter)

Mississippi L-5
c/o Robert McWilliams
Box 5563
University, MS 38677

John Muir High School L-5
1905 Lincoln Avenue
Pasadena, CA 91103

Niagara Frontier L-5
c/o Elissa Wynn
40 Kings Trail
Williamsville, NY 12122
716/689-9140
or Michael Cooper
716/691-4584

North Carolina State L-5
c/o Robert Baldwin
Rt. 4 Box 121A
Waxhaw, NC 28173

OASIS
c/o Terry Savage
P.O. Box 704
Santa Monica, CA 90406
(213) 374-1381 or (213) 536-3209
(Has newsletter)

Put It In Orbit Society
c/o George Timothy Bigham
Rt. 2 Box 82
Huntsville, TX 77340

Reno L-5
c/o Ray Bryan
1071 Glen Meadow Dr.
Sparks, NV 89431

Tulsa L-5
c/o Tom Huffman
3424 E. 41st
Tulsa, OK 74135

UCLA L-5
c/o John Blanton
Box 77206
Los Angeles, CA 90007

University of Houston L-5
c/o Physics Dept.
University of Houston
Houston, TX 77004

Urbana L-5
c/o Steve Vetter
168 Townsend, U.R.H.
Urbana, IL 61801

Virginia Tech L-5
c/o Kimber Smith
4016 W. Pritchard, VPI & SU
Blacksburg, VA 24061

West European L-5
c/o Roger Sansom
45 Wedgwood Dr.
Lilliput, Poole, Dorset
BH14 8ES England
(Has newsletter)

Williamsburg L-5
Box 1795
Williamsburg, VA 23185

Space settlement oriented groups—cooperating with but not affiliated with L-5.

Mankato Space Society
Box 58 Activities Office
Mankato State University
Mankato, MN 56001
or Dan Lundquist (507) 345-3624

The Chicago Society for Space Settlement
4 N. 186 Walter Drive
Addison, IL 60101

Spaceworks
c/o Robert Topple
1930 Quince Street
Denver, CO 80020

Space Futures Society
c/o Richard Bowers
3059 Cedar Street
Philadelphia, PA 19134
(215) 739-7780

S.P.A.C.E.
6th Floor
575 Boylston St.
Boston, MA 02116

Bay Area L-5

The Bay Area L-5 Chapter is sponsoring a major public address by J. Peter Vajk at U.C. Berkeley on Friday, November 3rd at 8:00 pm (room to be announced). Those who have not heard Dr. Vajk before are urged to bring friends and to help publicize this speech as widely as possible.

We publish a monthly newsletter which announces our meetings and other space-related events around the Bay Area. Chapter supporter dues are $5 per year; newsletter subscription only is $2.50. Anyone interested in participating with us please contact David Brandt-Erichsen (President), 814 Miramar Ave., Berkeley, CA 94707, 526-9346 (home), 645-5990 (work), or Ross Millikan (Vice-President) or Jess Millikan (Secretary) at 223-2463.

South Bay people can also contact the National Action Committee for Space (Northern California Chapter) at P.O. Box 11343, Palo Alto, CA 94306, or call Ron Jones at 969-1115.

Astronomers' Note

The Astronomical Society of the Pacific is presently compiling a set of regional astronomy directories, listing planetariums, observatories, amateur astronomy groups, astronomy courses (which are open to the general public), lecture series, and stores carrying astronomy equipment. Anyone involved with such activity who has not yet been contacted is asked to send for a questionaire to the address below.

Please send all correspondence to:

Directories
Astronomical Society of the Pacific
1290 24th Avenue
San Francisco, CA 94122

Texas L-5

The local Texas chapters of the L-5 Society wish to announce the formation of a new, statewide organization known as the "L-5 Society of Texas". The chartering convention for this group was held on August 26th, 1978, at 21st Street College House co-operative dormitory, Austin, Texas. A constitution was adopted and officers elected for the Society.

The functions of the L-5 Society of Texas are to promote unity of aim and effort among local Society chapters in Texas and to provide a focus for concerted undertakings on a scale not previously possible with the divided status of the various local chapter. The L-5 Socity of Texas is in all respects subordinate to the national L-5 Society and wholeheartedly wishes to further its aims. It is to be hoped that our Texas Society will not retain its position as the only regional branch of the L-5 Society for long, and that others will follow our example and create similar organizations across the country. We in Texas feel that such a network of unified regional Societies would give the national L-5 Society a more solid underpinning and allow endeavors of considerable scope and size to be undertaken by the L-5 Society with a greater expectation of an influence and success.

We invite correspondence from any local L-5 Societies who desire to form a similar regional Society branch or are willing to consider such a step. A newsletter will also be published by Texas L-5.

Officers elected at the L-5 Society of Texas state convention were:

PRESIDENT: Ron Nickel
VICE-PRESIDENT: John Strickland
SECRETARY: Joseph Vissers
TEASURER: R. J. Howe
COMMUNICATION OFFICER:
Claudia Crowley

Address all correspondence to:

L-5 Society of Texas
Box 8213
UT Station, Austin, TX 78712

Letters

May I be permitted to respond to Richard Stutzke's letter (**L-5 News**, May 1978, pp. 16-17) about the possible Soviet shuttle?

In July 1977 the L-5 Society, West European Branch, **'L-5 WE Newsletter'** carried an exclusive article of mine that discussed the possible design of a Soviet Shuttle—long before **Aviation Week & Space Technology** carried their article! In my article, written in June 1977, I suggested that the Soviet Shuttle would be a modified delta wing shape with two main propulsion engines and with a low cross range capability. It was suggested that it would have a glide-back capability only. I suggested a payload bay of 15 metres length by 5 metres diameter with a cargo payload weight of 18,000 kg, into a 210 by 250 kilometre orbit with inclination of 55 . I suggested a crew complement of up to four persons. I further suggested that the launch vehicle would be a modified Proton booster with side boosters being recoverable by parachute.

I believe that the reported recent drop tests will have been of one of a number of possible candidate designs of a Soviet shuttle and would have been a scaled down model. I believe that we are still some years away from seeing a Soviet Shuttle in orbit and that the USA will be first in June 1979. I think that the Soviets are more intent in accumulating practical experience with their Salyut space station—both in terms of longevity of flight, experimental data processing, resupply missions, international crews and multiple dockings. In this area, they are overtaking the USA and, I believe, it is the permanent manned space platform that is the key to space industrialization and that the Soviet Union, like the United States, has recognized this.

Phillip J. Parker, AFBIS, AMDPMA
Director, L-5 Society (West Europe)

This isn't entirely my idea; I first saw it mentioned in the June 1977 issue of **Analog** magazine, but I think it would be worth it to pass on to members.

I'm sure everyone has heard rumors that either we or the Soviets are designing laser or particle beam weapons which, mounted on satellites, would provide an effective defense against enemy ballistic missiles. So, if we can convince Congress that this would be feasible, we could urge that it would be safer and cheaper to manufacture the satellites at L-5. The Department of Defense should be quite enthusiastic, since building L-5 would only take about one-tenth of their budget . . . quite a small fraction of what our current network of anti-missile missiles costs.

True, I don't think we could entice the Pentagon into building the colony *just* for the satellites in the ABM network; but, when combined with SSPS, it makes an excellent "extra added attraction."

Robert K. Rose
Lakewood, CA

Hans Moravec's spinning skyhook (**L-5 News**, August '78) is clearly meant to remain straight. But a skyhook that is a simple cable will offer no resistance to the bending tidal forces that the skyhook will feel when nonvertical. To stay rigid, the skyhook should be a triangular lattice of cables, with a maximum width of perhaps 10% of the length. Because cable strength is diverted to retain rigidity, the performance parameters for a Kevlar skyhook may be more like those Moravec gives for fiberglass.

Also because of tidal torques, the angular velocity of the skyhook about its center will not be uniform. The peak will occur when the skyhook is vertical. This means that a skyhook that touches down precisely six times per orbit will have a radius slightly less than a third of the planet's radius.

Another point: no material is perfectly rigid. A skyhook in operation must be viewed as a very long spring with longitudinal vibrations. Periods would be on the order of several minutes, and amplitudes could reach a kilometer. Some kind of damping system is obviously needed.

Is anybody making plans to mine Jupiter for metallic hydrogen (which may be a room temperature superconductor)?

Kenneth A. Brakke
Math Dept.
Purdue University
West Lafayette, IN

The rotational velocity of Jupiter at the equator exceeds the escape velocity of Earth. Even without its dense atmosphere, escaping Jupiter's gravity is well beyond our technology. Perhaps a better approach would be to manufacture metallic hydrogen with the use of heavy pressure. I expect, however, that metallic hydrogen would change state if the pressure were taken off. — CH

I have not yet had an opportunity to read the article on SPS dangers in **Mother Jones.** However, it seems that the arguments in Matthew Swass's letter (August '78 **L-5 News**) are as full as holes as any supposedly reasoned critique could be.

A solar power satellite does not need to outrun an attacking missile in order to protect itself. With high power radar and lasers or charged particle beam projectors it would have ample time to detect and destroy any rocket as it made the long climb to geosynchronous orbit. Further, I seriously doubt that a rocket capable of destroying an SPS could be launched for a "few million dollars". Just look at the balance sheets of OTRAG.

In the final analysis it is necessary to depict the SPS for what it is, a source of immense power. How it is used will depend on how it is constructed and managed, and that depends on us.

Anthony Weiner
Findlay, OH

SPS is a great idea but the idea of cities in space will **never** be accepted by the public. Your philosophy should change. Shoot for SPS first and then when that works, talk about cities in space. Otherwise Proxmire, will veto **all** your ideas. When you folks become more realistic in your goals-write me and I'll sign up again. Remember, as far as Congress is concerned, when you ask for too much, you usually get nothing!

Joseph Lanza
Reading, MA

Thank heavens Goddard and Von Braun didn't have that philosophy!—CH

I just want to let you know that there will be a letter campaign to save the shuttle Enterprise. It will demand that the Enterprise not be scrapped, but be allowed to fly with the other shuttles. This letter campaign will begin in October. It will mostly involve Star Trek fans and should be fairly large. I am sure that L-5 members would be interested. Please tell them about this campaign; I want to ask them to write to their congressmen.

John P. Hedstrom
University, AL

While I am for the goals of space settlements, I take exception to some of the articles in the newsletter as to the reasons and means by which this is assumed to be accomplished.

First, in the area of electric energy. There is no shortage of electricity. In the future electricity can be generated by means of the known nuclear technology.

Second, the value of "space mining" is greatly overestimated. There is no real shortage of chrome, nickel, manganese, iron, silicon (quartz) and so on. For example, along the coast of northern California and southern Oregon are huge beach sand deposits containing Cr, Ni, Pt, Au, and Fe. These deposits are about 100 miles long, average 20 miles wide, and are of unknown depth, but have been tested to depths in places of at least several hundred feet. Off the southern coast of California within only a few miles of the beach lies a huge deposit of manganese nodules in only a few hundred feet of water. Easily reachable by ocean going dredges. I have been a prospector for most of my 60 years and I know what I am talking about.

James A. Reese
Glendale, OR

Help! Is anyone there? Anyone working on or interested in the habitat interior design problems of overcrowding, isolation, and artificiality? I would like to correspond with others concerning these and the related city planning issues. I am working on a master's thesis dealing with these subjects and any information, ideas, or papers would be a great help. If you have written material or would just like to exchange insights and ideas on interior design, please write me:

Bev Isbell
Rt 3 Box 231 Rd 21
Orland, CA 95963

The column "Careers In Space" (August, 1978 issue, page 9) has prompted this note to you. I am currently looking for a PhD program in Clinical Psychology with an emphasis in Space Medicine—Space Psychology—whatever it might be called.

The usual "Guide to Graduate Study" lists no such program. I wrote to the American Psychological Association who suggested writing to NASA. NASA has not answered.

Some school in this country must have a program for space related Clinical Psychology. Do you have any idea or suggestions? Any help will be **greatly** appreciated.

Mary Snell
Bay Area
Chapter Member
Berkeley, CA

Space Studies Institute

Dear Friend:

It gives me great pleasure to announce the establishment of the Space Studies Institute located here in Princeton, New Jersey.

The goals of SSI are to support and engage in research which will develop the "High Frontier" and the application of existing technology to open for human benefit the virtually unlimited resources of energy and materials now existing beyond the biosphere of the Earth.

SSI is the outgrowth of a rising interest in the High Frontier concept. Its highest priority at the present time is the purchase of equipment and materials for experiments proving and demonstrating vital components needed in order to bring the High Frontier concept into reality.

SSI is a nonprofit organization and maintains a small staff — its officers serve without compensation. The Institute relies mainly on tax-deductible contributions and gifts for its support.

Historically it has been a special characteristic of America to naturally form private voluntary associations to carry out tasks for the benefit of society. SSI is an example of such a voluntary organization.

The Space Studies Institute depends for its existence on your help. We welcome your support in the High Frontier adventure and ask you to take a moment to fill out the coupon below and return it to us with your donation or subscription which entitles you to a free subscription to our Newsletter.

Sincerely,

Gerard K. O'Neill

Gerard K. O'Neill
President

Space Studies Institute
P.O. Box 82
Princeton, New Jersey 08540

I am interested in becoming (please circle) a Subscriber ($10) and/or Contributor ($__________) to this nonprofit Institute and understand that my tax-deductible gift is toward support of one year's equipment purchases and administrative work of SSI.

(BLOCK LETTERS, PLEASE)

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L5 NEWS

November 1978

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 3, NUMBER 11, NOVEMBER 1978

In this issue:

1 Russia's Guest Cosmonaut Program: A Commentary *Jim Oberg, an expert on the Soviet space program, documents his contention that the USSR "guest cosmonaut" program is purely cosmetic.*

3 What Are Solar Power Satellites? *This special supplement to the* **L-5 News** *is an in-depth treatment of the most controversial future space project. The lead article outlines the ABC's of power satellites.* **Solar Power Satellites: Boon or Boondoggle** *(pg. 5) is a lively debate over issues of cost, feasibility, military hazards, environmental impact, and more. With* **SPS in the Time of Timidity** *(pg. 7) laser pioneer Arthur Kantrowitz lambasts antitechnologists.* **A Solar Power Satellite Bibliography** *(pg. 13) is a guide to those who wish to get deeper into the topic. What is the L-5 Society position on SPS? Find out on page 14.*

15 News Briefs *A modern day Robin Hood tries to finance space colonies in* **Far Out Crime.** *A more socially responsible method is outlined in* **LA Space Capitalists Form Investment Club.** *Folks who've been holding their breath waiting to hear what Carter's space policy will be, can end the suspense by reading* **Carter Announces Space Policy.** *And another nation prepares to enter the space age in* **Egypt to Put Small Payloads Aboard Space Shuttles.**

16 Inside the L-5 Society *Job opportunities and local action are featured.*

17 Letters

Cover: Record breaking second crew of Salyut-6, Vladimir Kovalyonok and Aleksandr Ivanchenkov, who hosted visits by Polish and East German "guest cosmonauts". (Photo courtesy **Novasti.**) (*Note this is a mockup of Salyut.*)

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Russia's "Guest Cosmonaut" Program

A Commentary

Triumphant return of Czech cosmonaut Vladimir Remek. (Photo courtesy Orbis.)

by Jim Oberg

With the end of the recent token space flights by East European cosmonauts, Moscow has once again demonstrated its skill in the political exploitation of space events. New 'space firsts' have been racked up, and world attention has again been focused on Soviet space achievements. But Western observers have been trying to determine the real significance and purpose of this series of cosmonaut launchings.

These international flights have been made as an adjunct to the ongoing expeditions involving the Salyut-6 space station. For almost a year, Soviet piloted and human-related spacecraft have been launched to orbit at a rate of about one per month. Old American records have been shattered, and new Soviet launches break records set only months before by previous Russian space crews.

But however important these long flights are, they clearly do not have the glamour of the 'foreign cosmonauts', who have attracted attention to an otherwise dull space expedition.

Three week-long "guest-cosmonaut" flights were made, one each in March, June, and August. On Soyuz-28, Czech Air Force pilot Vladimir Remek was co-pilot; on Soyuz-30, it was Polish pilot Miroslaw Hermaszewski; on Soyuz-31, it was East German Air Force officer Sigmund Jahn. All the actual flying was done by experienced Soviet cosmonauts.

Superficially, the missions looked like purely political 'hitch-hiker' stunts. They seemed to have been designed solely for the purpose of strengthening the hands of the pro-Soviet regimes in each country. Nothing appeared to have been done that could not just as easily have been done by all-Russian crews. Indeed, little was accomplished that would have been missed if the flights had not taken place at all.

For some mysterious reason probably connected with low level of training of the pilots (the East Europeans each got little more than a year of preparation, while Russians have had from four to ten years of training), all three flights were launched at nearly the same time of day, late in the afternoon. Since this condition is only met once every two months, the requirement often dictated that the flights occur at inconvenient and useless phases of the marathon expeditions.

That is, the Czech flight was launched only a week before the end of the 96-day expedition last March, a timing which could have had no logistical, psychological, or practical justification. The Polish flight was launched only days after the beginning of the second long-term expedition, again without any practical need. Only in the case of the German flight was there anything substantial accomplished, when the visiting crew left their new "Soyuz" craft and returned to Earth in the old Soyuz used by the Russians in June. If there had been no "foreign cosmonaut" program at all, only the last of these three flights need ever have been flown.

The purely symbolic nature of these flights is further underscored by the fact that only one flight will be made for each Soviet-bloc country. In case of accidents, two pilots from each country underwent training. The first three pairs arrived in Moscow in December 1976, and new pairs of candidates from Hungary, Romania, Mongolia, Bulgaria, and Cuba began training last March, but only one from each country will fly.

Considering the political gains to be made, it would not be too surprising if the Cuban space pilot were selected on racial as well as national and ideological grounds. Moscow would be understandably delighted if the first black in space were to be launched on board a Soviet spaceship.

In many ways, the foreign cosmonaut program is reminiscent of the "woman in space" stunt fifteen years ago. Apparently on direct Kremlin orders, the Soviet space program waived all standards of flying skill and picked a popular young factory worker to receive a minimum amount of space training. Valentia Tereshkova made her headline-grabbing flight, after which her backup girls were fired and she was grounded forever, assigned to political and public relations duties for the rest of her life. The same fates probably await the East European cosmonauts.

When the "guest cosmonaut" program was first announced in mid-1976, Western observers naturally assumed that the East European co-pilots would be the civilian scientists and engineers who had for years been working with their Soviet colleagues on cooperative unpiloted space activities. They were clearly the most qualified for conducting useful space experiments.

But on the other hand, the East European intelligentsia is generally considered politically unreliable by their governments. A defection from the "guest cosmonaut" program, especially after the flight, would ruin the whole value of the effort. So instead of *qualified* individuals, *safe* individuals were chosen.

Remek's background seems typical of these standards. He is a staunch member of the Czech communist establishment, the son of the deputy defense minister. After the Russian invasion of 1968, flight cadet Remek (he then was only 19) was part of a small cadre of pro-Soviet loyalists who toured armed forces units lecturing on why the Soviet takeover was a blessing. And prior to his selection as a cosmonaut-trainee, he had spent many years in Soviet military schools and institutes.

Hermaszewski, too, is a member of the Polish communist ruling class. His brother is a top Air Force general. The background of the East German is believed to be similar.

Little is known about the backup cosmonauts from Eastern Europe, except that their spaceflight chances are now zero. The Czech backup Oldrich Pelczak, the Polish backup Zenon Jankowski, and the East German backup Eberhard Kollner have returned home, their usefulness ended and their once in a lifetime chance for a space mission now aborted.

Why didn't the Russians allow both Remek and Pelczak to fly without a Soviet pilot on board? The two Czechs would have landed their spaceship in West Germany!

The reception of Remek in Czechoslovakia was not all that the political theorists had hoped, since the Czechs have developed a sharp sense of humor about Soviet domination. Remek became the butt of numerous pointed jokes and ridicule.

Why, for example; didn't the Russians allow **both** Remek and Pelczak to fly the Soyuz-28 mission without a Soviet pilot on board? Wags answered that in that case, the two Czechs would have landed their spaceship in West Germany.

And why did Remek come back from space with red hands? Baffled and worried space doctors inquired urgently about the cause of this hitherto unknown space malady, but Remek explained it: "Well, in space, whenever I reached for this or that switch, the Russians cried "Don't touch that!" and slapped my hands."

The timing of the present Soviet "guest cosmonaut" program does not seem to have been an accident. It coincides with the beginnings of West European activities leading up to the launch of the first astronauts from Western Europe for Spacelab flights in 1981.

After a year of screening, three Europeans have already begun space training in Europe and America. They are all qualified engineers and scientists: Ulf Merbold from West Germany, Wubbo Oeckels from Holland, and Claude Nicollier from Switzerland. They will take turns flying on sequential Space Shuttle missions which carry European Spacelab experiments.

These future European astronauts achieved their status through professional standards, and are going to be as fully trained as their American colleagues. They will make genuine contributions to the success of the Spacelab missions. In these and other ways, this program is markedly superior to the Soviet "guest cosmonaut" program, with one major qualification: *the Russians did it first.*

Curiously, despite the Soviet priority for the selection of foreign nationalities for one-time space debuts, Moscow has still exluded many of its own domestic minorities. No cosmonauts have been (or are likely to be) Latvian, or Armenian, or Kazakh, or Jewish, or any other non-Slavic ethnic group. But for the propaganda value, additional foreign cosmonauts may well be selected in the coming years from North Korea, Vietnam, Albania, Ethiopia, the Palestinians, and other useful nationalities.

Despite the symbolic beginnings of this "foreign spaceman" program, it may yet continue and expand into something more practical and justifiable. The American Spacelab program of the 1980's,with its "space quests" from Western Europe, Japan, Australia and other space-minded countries, may prod Moscow into expanding its own program in a more substantive way. And the suggested Shuttle-Salyut docking in 1982-1983 may provide justification for Russia and America actually exchanging astronaut-trainees for that flight. The procedures and practical considerations have already been worked out.

Those possibilities may fully justify the otherwise purely public-relations approach exemplified by Moscow's current "guest cosmonaut" stunts. Symbols created for one purpose often have a life of their own, and "breaking the ice" for foreign nationals in space may be a valuable psychological development in the history of space exploration. Short-term Soviet propaganda benefits and motivations may fade as the long term world benefits become evident.

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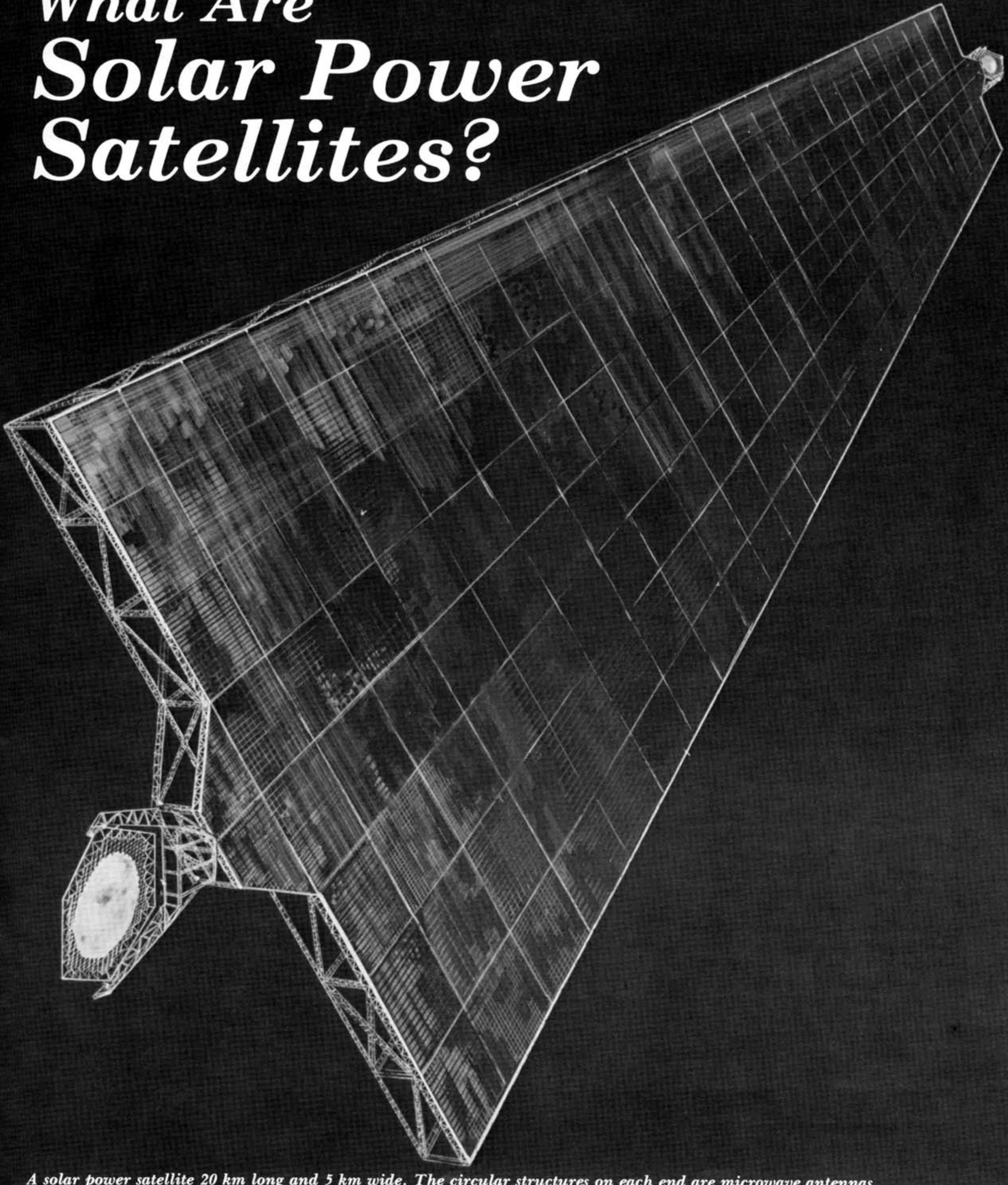
What Are Solar Power Satellites?



A solar power satellite 20 km long and 5 km wide. The circular structures on each end are microwave antennas.

What Are Solar Power Satellites?

by Carolyn Henson

Solar power satellites may someday catch the Sun's energy and beam it to Earth.

How will they collect energy?

They might use silicon or gallium arsenide or "sandwich" solar cells to convert sunlight directly to electricity. Or they might convert sunlight to heat which can power thermionic converters or turbogenerators. There are other possible ways, as well.

How will they get the energy back to Earth?

One way is with microwave beams, another is by infrared laser. Both can pass through clouds, although a rain storm can block the infrared light.

Once the energy reaches Earth it must be converted to electricity. Microwaves are converted by rectifying antennas. An infrared beam might be fed into a "reverse laser" or specially tailored solar cells which would convert coherent light into electricity.

How intense would the microwave beam be?

At the center of the beam it would be 23 milliwatts/cm^2 (A milliwatt is a thousandth of a watt. Noonday desert sunlight is about 0.1 watt/cm^2.) Three kilometers from the center of the beam the intensity falls to 10mw/cm^2, the US industrial standard for safe exposure. The most stringent microwave guideline in the world is 0.01 mw/cm^2. This level is reached about 13 km from the center of the beam. This level could be reached far closer to the center of the beam by using slightly more costly transmitter optics.

You may wonder how the microwave antennas could compete with ground solar power plants. (After all, the microwaves the antenna receives are less than a quarter of maximum sunlight intensity.) First, the microwaves are converted back to electricity about 90% efficiency, whereas sunlight is unlikely to be able to be converted at any better than 20% to 30% efficiency. Second, the microwaves come in at the same intensity day and night all year long. Thus a given area of microwave antenna could provide 3 to 10 times as much electrical output as the best possible Earth based solar farm.

What would energy from a solar power satellite cost?

Researchers believe the capital cost, including the ground receiving station, would range between $1000 to $2000 per kilowatt installed capacity. This would be competitive with nuclear and ground-based solar power. However, it should be emphasized that these are estimated costs.

How large will solar power satellites be?

...power satellites are...a major stepping stone towards opening up the solar system for human habitation.

The most popular design at present would be almost 100km^2 — about the size of Manhatten island. A satellite that size would provide ten gigawatts (10 billion watts) of electricity. This is enough to power the entire city of New York with plenty to spare. Because of inherent optical limitations, to be economical a microwave style power satellite would have to be at least 25km^2 in area, transmitting 2.5 gigawatts. Some researchers have suggested the use of giant microwave mirrors in space as a way to deliver smaller power beams. Power satellites using laser transmission could also be much smaller.

Where will solar power satellites be located?

They might be placed in orbit where they will be continually, or almost continually, in the sun. Geosynchronous orbit has advantages because the satellite would always hover over the same place on Earth. There are several sun-synchronous orbits where the satellite circles Earth along or near the dawn-dusk line.

How will power satellites be built?

They might be prefabricated and shipped into orbit where space workers would build them.

Another possibility is that ores from the Moon or asteroids could be processed into raw materials in lunar or space factories. Power satellites, space craft, space habitats and more could be built in these factories. However power satellites are built, they are a major stepping stone towards opening up the solar system for human habitation.

Why do researchers believe solar power satellites could be the key to cheap and plentiful power?

First, sunlight in space is abundant — six to ten times as much per area as we receive on Earth. And it isn't interrupted — no long winter nights and rainy spells.

Second, space solar collectors can be made out of exceedingly light materials. In free fall they need only resist tidal forces, orbital perturbations, micrometeorites, solar wind and light pressure. Earth structures are subjected to gravity, wind, rain, hail, roosting birds (and their inevitable aftermath) and more.

Third, solar power satelites are a young technology. Remember how pocket calculator prices plummeted? Space transportation, solar cells, space processing, fabrication, construction, mining of extraterrestrial materials, and more are following the same trajectory.

We've told you what the solar power satellite is. But we left one thing out. It is also controversial. That's what the next pages are about.

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Solar Power Satellites: Boon or Boondoggle?

Solar power satellites (SPS) once inspired nothing worse than disbelief. But now that their technical feasibility has been established, anti-SPS forces have started doing their homework. Collected here are a series of pro and con statements. The individuals quoted were never all in the same room together. This "debate" is composed from statements made by Senator Charles Percy (R-IL), Garry DeLoss, a professional lobbyist with the Environmental Policy Center, Mark Gibson, who did a study of SPS at the University of Maryland; Gordon Woodcock, solar power satellite study manager for Boeing, and Carolyn Henson, editor, L-5 News.

Are solar power satellites a boon or a boondoggle? Judge for yourself.

Mark Gibson

Estimated R&D costs, just to develop technology— $40-80 billion (JPL estimates $60 billion).

Estimated cost per satellite— $15 billion. (Peter Glaser quotes $7.6 billion for a 5 gigawatt satellite, other figures go as high as $40 billion.)

Total cost: about $500 billion!

Cost to develop the Heavy Lift Launch Vehicle is $10 billion, included in the R&D costs.

Cost per kilowatt estimated at $1000-1500/kw, in the range of other power sources (nuclear is $1100/kw). As Charles E. Hansen, director of International Business Services, points out in his Report on Economic and Technology Development of the SPS, the aerospace industry has a past record of underestimating costs of large projects. He suggests that we should expect the cost to be at least double the projected cost, raising the cost to $2000-3000/kw, well out of the competitive range.

The cost projections vary greatly between reports. The discrepancies make the validity of any of the figures rather doubtful.

Component costs — The percentages of the capital costs quoted for the receiving antenna costs are as follows: Peter Glaser — 17%, Johnson Space Flight Center — 42%, Marshall Space Flight Center — 8%. For a $7.6 billion 5 Gw satellite, Glaser predicts the receiving antenna to cost $1.3 billion. run at least $2 billion.

Transportation costs—The costs of propellants are assumed to be the same as today's costs. The cost of transporting materials is assumed to be $10-20/lb, while the present shuttle costs are $300/lb. Increases in transportation costs will significantly increase the total system energy costs as well as the total cost.

According to NASA, in order to be competitive with terrestrial systems, the SPS must meet all projected electricity demands by 2025. This means that 1120 **Gw (112 ten Gw SPS) must be installed at** an average implementation rate of 3.37/yr. Any lowering of the rate or the level of installed capacity would significantly increase costs. The systems could be cost-**effective at 300 Gw (30% of the electricity demands).**

All terrestrial cost comparisons with the SPS have been between solar power tower (which is not economical) with a back-up system and the SPS without a back-up system. This deflates the SPS costs while inflating the costs of ground-based systems. It also overlooks other viable, economic ground-based systems and decentralized energy systems.

...the aerospace industry has a past record of underestimating costs of large projects.

NOTE: At present, the amount of energy produced that is converted into electricity is approaching 30%. (U.S.)

Gordon Woodcock

The costs to develop the technology have been estimated at $150 to $250 million. Costs through engineering test units in space have been estimated at $3 to $6 billion. In fact, no one has proposed that 40 to 80 billion dollars of government funds be committed. These large sums represent the total development and industrialization investment required to build the first 10,000 megawatts of SPS generating capacity and also provide the industrial capacity to continue to install 10,000 megawatts per year indefinitely. Government funds need not be spent for all of this. If the SPS is economically sound, commercial investment would be expected to provide the bulk of the $40 to $80 billion.

Further, it is not presently proposed that this entire program be accomplished. The legislation now before Congress would fund sufficient technology and environmental research to enable a responsible evaluation as to whether such a program should be accomplished. The issue of the tens of billions of dollars arises out of confusion between (a) true technology research, and (b) the creation of sufficient industrial capacity to install generating capacity on a reasonable scale.

SPS proponents have included industrialization costs in candid statements of the total real costs involved in bringing a major new energy system into being. The problem has been candidness is accounting all identifiable costs rather than in SPS being an exceptionally high cost system. (Under the **bookkeeping rules usually adopted by distributed-energy enthusiasts — interest costs not considered — the construction of even just the first SPS at 40 to 80 billion dollars would be economically feasible. That is to say, if all of the presently — identified development costs were written off against a single SPS, it would pay for itself in about 30 years if interest costs were not considered.)**

Overruns have been experienced by the aerospace industry, particularly in weapons systems where the maintenance of a technological edge over the military competition is accorded more importance than minimizing costs. In fact, the propensity of the aerospace industry for cost overruns is no worse than that exhibited by construction of sports stadiums. Cost overruns do not arise from inability to estimate cost, but rather than a tendency of procurements agencies to change their minds about what they really want; from competitive bidding to beat the competition; and from poor management. In the case of the Boeing Company, about 75% of its business comes from delivering aircraft to commercial airlines at fixed price, with performance and delivery date guarantees, and in a market in which all development costs are incurred by Boeing and amortized against eventual delivery of 300-500 airplanes, most of which are not yet sold at the time the project is launched. If Boeing were not capable of accurately estimating costs, the company would have long since gone bankrupt.

It is important to recognize that solar power satellites have not yet entered the phase of competitive cost estimating in which under-bidding the competition is of significant importance. The cost estimates that have been published are those that have been calculated by the cost models.

Garry DeLoss

The supposedly objective cost estimates for the SPS are being made by the corporations, NASA space flight centers, consulting firms, and academicians who have a vested interest in encouraging a massive government commitment to SPS. This leads to a cost estimates that are mere self-fulfilling prophesies, or what one critic, Dr. John Cummings of the Electric Power Research Institute, calls 'legislating all the answers.' Richard Caputo, who directed a two-year Jet Propulsion Laboratory (JPL) study of the SPS recognized the same pattern of behavior, and characterizes the cost estimates he examined as based on 'assumptions of success' rather than a real data base. The SPS proponents appear to begin by calculating the cost goal which the total SPS system must meet to compete with other energy sources, and then allocate that cost goal among the various subsystems of the SPS. Hence, they tend to reach similar conclusions about the total cost of the SPS based on widely varying estimates about the costs of the sub-systems.

GW

The idea that the current SPS cost estimates are simply allocations of cost goals probably came from papers published by myself and Gregory in about 1974, in which such allocations were shown, and argued to be attainable. This allocation of goals, by the way, is widely used; it is called "Design-to-Cost." Design-to-Cost analysis defines, on an overall economic basis, a set of cost targets for a system or a project. These targets are then allocated against elements of the system, and the design activity attempts to meet, or beat, the allocated targets. SPS cost figures published in 1976-78 are cost estimates and not target figures. The present cost estimates indicate that SPS electricity will be competitive with the centralized sources, e.g., breeder reactors and fusion, with which SPS should be compared. It is nonsense to compare SPS with rooftop solar collectors because these systems address different segments of the energy market.

MG

Energy payback period—estimates go from a low of 3 years to a high of 16 years. Gordon Woodcock:

A recent JPL study (900-805, Aug. 1978) determined energy payback periods of 0.7 to 1.6 years; Boeing estimates are 1 to 3 years. The consumption of rocket propellants to launch one SPS per year is equivalent to less than 1/1000th of current U.S. fossil fuel consumption. Conversion of natural gas (a supposedly scarce resource), that is now **wasted by burning at the wellheads**, into propellants would suffice to launch **more than 50** SPS's per year.

It is nonsense to compare SPS with rooftop solar collectors because these systems address different segments of the energy market.

One article alleged a high use of platinum. That SPS design was abandoned over five years ago. Current designs use **no** platinum and very little aluminum. Small quantities of refractory metals are used in certain speciality parts. Critical resource consumption is miniscule compared to that for most other energy options and especially so compared to that for ground-based solar. The **principal raw material requirements for** current SPS designs are sand (for silicon, glass, and concrete) and steel, which has replaced aluminum in the ground receiver support structure. Requirements for foreign-supplied resources likewise have been minimized.

MG

In order to put an SPS in space, new equipment must be developed, including a Heavy Lift Launch Vehicle which is to be five times the size of today's rockets. The cost is estimated by Boeing to be $10 billion. Large launching complexes are needed to handle the weight of the rockets. Some sort of automatic assembly "factories" as well as other equipment for stock flights must be developed.

To put enough SPS in orbit to meet our electricity needs, there will have to be 4-6 flights daily for 30 plus years. Grumman estimates 150 launches per satellite, using a rocket with a carrying capacity of 400,000 lbs. NASA's present shuttle has a carrying capacity of 65,000 lbs. Other estimates go as high as 500 flights/satellite.

GW

It is sometimes argued that space-based arrays must be more expensive than ground-based arrays. The argument is based on the premise that something technically sophisticated must cost more than something simpler. One can, however, buy a scientific pocket calculator for fewer 1978 dollars than one could buy a high-quality slide rule in 1968 dollars. As a result, one can no longer buy a high quality slide rule at all. Since solar cells used in the SPS will be of lighter weight than those presently under development for ground-based service, they will therefore consume less resources and ultimately be lower in cost. Further, for a ground based system, the structural support systems will dominate the ultimate cost of photovoltaics; whereas in space, structural systems are minimized due to lack of gravity and wind. Space-based photovoltaic systems should ultimately become much cheaper in cost per unit area as well as collecting about six times as much energy per unit area as the equivalent ground-based system.

GD

The SPS proponents prefer to set up the straw man of a centralized solar energy powerplant alternative and then knock it down by claiming high costs for land acquisition, electricity storage, and transmission lines up to 2,000 miles long from solar powerplants concentrated in the Southwestern states. Even the most objective of the SPS studies, the report by JPL, compared the SPS with what its director has described as the 'worst solar terrestrial options,' centralized solar energy powerplants at sites remote from their markets . . . The JPL study concluded that the SPS would cost more than a land-based, centralized solar energy powerplant using a solar thermal process and fossil fuel backup system, and about the same as a centralized photovoltaic solar energy system with a fossil fuel backup system.

If the SPS costs were compared with decentralized solar electric systems using photovoltaic cells, the SPS would look

(Continued page 9)

Arthur Kantrowitz is seen here against a backdrop of the Andromeda galaxy. (Photo courtesy Charles Divine.)

The Solar Power Satellite in the Time of Timidity

by Arthur Kantrowitz

The time of timidity is best defined by contrast with the idea of progress. Progress to my mind is best described by the distinguished philosopher of science, Sir Karl Popper's description of the scientific method, namely it is trial and the elimination of error. By contrast, in the time of timidity we eliminate the errors first. Before we act in the time of timidity we will insist on a certainty human beings can never attain.

Perhaps there is one way that predictability can be achieved. If we make life hard enough for the creative people among us, then maybe they will not endanger the technological forecaster. Contrast this with a typical time of technological progress. Adlai Stevenson, in an address he made inaugurating a Xerox research laboratory, told a story about how F.D.R. in 1937 wanted to get the best estimate of the scientific community as to what was coming in the next decade. Accordingly, he summoned a committee of the best scientists in the country, and as Stevenson describes the result, he found himself "on a par with the greatest scientific minds of the time, —for I, too, failed to foresee nuclear energy, antibiotics, radar, the electronic computer and rocketry." In a time of timidity technological forecasting is not so frequently disrupted by technological surprise, thus the elimination of error before trial is a doctrine which carries within itself the basis for its plausability. If, indeed, we become a stagnant society, then predictability will at last be accessible to us. There are two caveats that I'd like to be sure you remember. First, that perhaps the domain of timidity might not be all inclusive. Unless the idea of progress can be stamped out everywhere we must expect that technological surprise might still intrude from those barbarian domains where the idea still survives. The second caveat is that in the nearly stagnant society any residual action may result in irreversible side effects whereas in a time of

Progress is best described by . . . trial and elimination of error . . . In the time of timidity we eliminate the errors first.

technological progress unanticipated side effects, which do not appear until years later, can be more readily dealt with by a technology which will have greatly advanced in the meanwhile. Thus, there are important forces that drive the nearly stagnant society toward complete stagnation or more hopefully toward a renewal of vigorous technological progress.

In my opinion the most important statement that has been made on the solar power satellite, after Peter Glaser's original proposition, is the carefully considered judgement on the feasibility of that proposition to be found in Amory Lovins' article in **Foreign Affairs,** October 1976, which made the whole thing clear by the statement: "The schemes that dominate ERDA's solar research budget—such as making electricity from huge collectors in the desert, or from temperature differences in the oceans, or from Brooklyn Bridge-like satellites in space—do not satisfy our criteria, for they are ingenious high-technology ways to supply energy in a form and at a scale inappropriate to most end-use needs. Not all solar technologies are soft. Nor, for the same reason, is nuclear fusion a soft technology."

It is important to understand that in this statement we hear the expression of a categorical imperative reminiscent of religious imperatives. This is a view which today has wide currency in Washington and in particular in DOE. I would quote the Department of Energy document: "Satellite Power System (SPS) Concept Development and Evaluation Program Plan, July 1977 — August 1980," dated February 1978. This document describes the most important issue of societal interactions of the solar power satellite concept as "the centralization of power sources, and hence society . . ." The proposition to reverse the centralization of society and to deny the United States energy opportunities because they do not fit the quasi-religious views of a small minority on the centralization of society constitutes a tyranny that the majority of the United States needs to understand far better than it does today.

My prediction is . . . that the time of timidity will destroy the solar power statellite OR . . . the solar power satellite will destroy the age of timidity.

In moving toward the decision to build a demonstration Solar Power Satellite we must, of course, assess the required technology and possible side effects as well as we can. However, we must anticipate that there will be considerable scientific and technological uncertainty regarding these assessments. We can expect a continuation of the partisan invasion of scientific uncertainty we have already seen. One of the problems of our time is that we lack any credible process for dealing with the high level of noise created by this partisan invasion. When there is active partisanship, partisan voices tend to obscure what scientific information we do possess. The development of due process for dealing with scientific controversy would make an important contribution by dispelling some of the fear of the unknown which is characteristic of the time of timidity.

Since we live in a time when predictions are fashionable, I'd like to make a prediction. My prediction is that the solar power satellite will not fly in the time of timidity, that the time of timidity will destroy the solar power satellite **OR** (and this is one of my fondest hopes) the solar power satellite will destroy the time of timidity.

Peter asked me to try to set the tone for this gathering, and I would propose:

> Arise creators of worlds yet unimagined
> You have nothing to lose but your limits.

(Invented for a review of **Limits to Growth**)

This is the text of a speech presented at the annual meeting of the Sunsat Energy Council, October 5, 1978. Dr. Kantrowitz is one of the foremost researchers in lasers and artificial hearts. He is a member of the board of directors of both the Sunsat Energy Council and the L-5 Society.

A solar power satellite under construction.

. . . Boon or Boondoggle

(continued from page 6)

even worse. Decentralized solar energy systems would be lower cost than centralized solar energy systems used in the JPL study because transmission costs can be eliminated, land acquisition costs can be reduced by using air spaces over rooftops and parking lots, and waste heat can be put to work near the generating site.

Objections by SPS proponents that electricity storage costs are an insurmountable barrier to lowering the cost of land based solar energy . . . have to be taken with a grain of salt. The people who suggest that major reductions in the cost of electricity storage are not likely are the same people who are extremely optimistic that costs for the various subsystems of the SPS will fall drastically.

GW

Solar power satellites and distributed energy systems really aim at different segments of the energy market. In a true economic sense, there is little competition between them. The distributed energy enthusiasts' arguments against the application of solar energy to centralized, continuous-supply energy systems are ideological rather than factual. In the first place, the often-advocated use of solar energy for home heating deals with an already decentralized energy system: almost every home already has its own heating plant. The appropriate argument is that home heating should switch from fuel-consuming to non-fuel-consuming energy sources. This is a relatively simple cost tradeoff which each consumer can make for himself.

Electricity generation could, of course, be decentralized. The technology has been available for decades in the form of diesel or gas turbine generators. Diesel generators at the neighborhood level would consume no more fossil fuels than centralized power generation; the slight differences in efficiency would be made up by differences in losses in power distribution. Diesel generators would require far less land than distributed solar electric systems, would require far less storage since they could run at night quite easily, and would have all the other so-called advantages of decentralized solar electricity except that they consume fuel and produce air pollution.

In order to illustrate the facts of the "diseconomies of scale" argument, I have constructed Table 1. This provides an approximate comparison of three distributed options with two centralized options. All are configured as continuous, rather than intermittent, supplies. Several points are significant:

- Some energy storage was allocated to the diesel/gas turbine system to allow for peaking.
- The storage allocated to solar photovoltaic is probably grossly inadequate unless cloudy-day backup capacity is available; no costs were assigned for such backup.
- The idea that storage costs can be drastically reduced is probably fallacious: Storage of electrical energy is today an economically mature market. Everyone who drives an automobile has under the hood an energy storage system for which the costs have been minimized for decades by intense economic competition: the battery.
- Installation costs for distributed systems were ignored. They will be significant for for distributed photovoltaics.
- Photovoltaics were priced identically for ground-based and space-based systems.

My conclusions from the table are that:

- Economies of scale are real.
- SPS may be able to compete with nuclear power, especially breeder reactors.
- Fuel-burning decentralized systems approach cost-competitiveness, but their costs are dominated by fuel costs, which makes the future uncertain. I do know of at least one instance where a building developer in New York City has recently elected to go with diesel generators in the basement of the building rather than buying power from Con-Ed at their rates, which apparently exceed the 6-7¢ kWh rate estimated for diesels.

. . . much energy could be saved if the hundreds of billions of dollars proposed for SPS development were instead spent on improving energy.

All of this is not intended to discredit the idea of distributed energy systems. There are many applications for distributed systems where large-capacity storage is not required or where centralized electricity is not available. In these cases, distributed energy systems offer advantages. In addition, there seems to be little advantage in generating energy in a high grade form, i.e., electrical, and then converting it to heat for heating buildings. Heating by direct collection of solar energy will continue to improve in economic attractiveness compared to consumption of fossil fuels.

When one examines the energy market rationally, it is clear that we need both central and decentralized systems for power generation. Arguing that SPS competes with decentralized energy is fallacious, because it does not. **Decentralized and centralized solar** energy aim for different sectors of the overall energy market and each should be evaluated on economic and environmental grounds with respect to legitimate alternatives.

GD

A utility receiving electricity from an SPS would require a reserve of standby power capacity equal to or greater than the SPS power of five gigawatts.

GW

Power pools carry from 10 to 20 percent reserve capacity and the loss of a five gigawatt generator in a 50 gigawatt power pool would not be catastrophic. In fact, the existing intertie between the Pacific Northwest and Southern California pools now transfers up to 4 gigawatts over a single transmission corridor. The loss of this transmission is equivalent to the shutdown to a SPS in terms of its effect on the power pool; these power pools today deal with that eventuality.

It is true that a 5 gigawatt unit size is uncomfortably large, even impractical, for many individual utilities and power pools today. However, in the time frame in which SPS power could be available, this does not appear to be a serious problem. In addition, smaller SPS's down to 2000-2500 megawatts are quite feasible; this smaller size would undoubtedly be built initially.

GD

No report on SPS economics that I have **reviewed includes speculations on how** much energy could be saved if the hundreds of billions of dollars proposed for SPS development and deployment were instead spent on improving energy efficiency.

GW

Conservation is frequently advocated as a more economical solution to our energy problem than construction of new energy sources: "the cheapest power plant is one that is never built." Actually, conservation and construction of non-fuel (i.e. solar) energy sources are economically equivalent: both are capital-intensive, neither consumes fuel. Conservation is more economical only to the extent that conservation measures are cheaper in cost per unit energy than new plant construction. It stands to reason that rational people will opt for the most economical of the alternatives. Many conservation measures are, today, indeed cost-effective, especially better insulation in homes, and are being implemented.

The potentials of conservation have been sometimes grossly overrated. The statement has been made that conservation techniques could cut energy use in building by as much as 600 gigawatts of generating capacity. In the first place, the **entire United States does not have 600** gigawatts of generating capacity. Further,

TABLE 1.
DISTRIBUTED VS. CENTRALIZED COST COMPARISON ILLUSTRATION

	Gas Turbine Generator	Diesel Generator	Distributed Solar Photovoltaic	SPS	Nuclear Plant
Generator Unit Rating	32.5 MW	5 MW	1 MW	5000 MW	1000 MW
Nominal Duty Cycle (hr./24 hrs.)	92%	92%	25%	100%	100%
Storage Required	2 kwh/kw rating	2 kwh/kw rating	3.2 kwh/kw rating	0.1 kwh/kw* rating	—
Net Avg. Output	26.65 MW	4.1 MW	180 KW	4960 MW	1000 MW
Distribution Loss	5%	5%	5%	10%	10%
Plant Factor	.8	.8	.95	.9	.7
Net Avg. Useful Output (kwh/kr)	1.775 x 10^8	2.73 x 10^7	1.42 x 10^6	3.52 x 10^{10}	5.52 x 10^9
Generator Cost Factor	Current Cost	Current Cost	\$40/M^2, 16%	\$40/M^2 plus other system costs.	Current Cost
Generator Cost	\$4.2 million	\$1.25 million	\$312,500 (7812 M^2)	\$10 billion	\$1.2 billion
Storage Cost (\$50/kwh, 10-yr. life)	\$3.25 million	\$500,000	\$160,000	\$25 million	—
Switchgear & Power Processor Cost (\$50/kw for switchgear and trans; \$150 for DC-AC converter)	\$1.63 million	\$250,000	\$104,000	Included in generator cost	Included in generator cost
Fuel Rate	3.13 kw$_{th/kee}$	2.78$_{th/kwe}$	—	—	3 kw$_{th/kwe}$
Fuel Cost, \$/kwhr th	.016	.016	—	—	.002?
Fuel Cost, \$/kwe	.05	.05	—	—	.006
Total Plant Cost, (excludes installation and land cost for distributed systems)	\$9.08 million	\$2 million	\$576,500	\$10.3 billion	\$1.2 billion
Annual Capital Charge Factor (depreciation, interest, taxes and insurance)	.18	.18	.18	.18	.18
Capital Cost/kwh	.0092	.013	.073	.051	.039
Storage Replacement Sinking Fund	.002	.002	.011	> .0001	
Distribution Cost/kwh	.002	.002	.002	.01	.01
Total Cost/kwh	.063	.067	.086	.061	.055

*Buffering to reduce transients if SPS beam shuts off.

electric power is not ordinarily used for space heating. I estimate the national space-heating usage as about 300 gigawatts thermal, equivalent to about 100 gigawatts electric. The figure of 600 appears to be about ten times too high.

MG

Defects are inevitable considering the size and high power level of the satellites. Repairs will be expensive if not impossible. Environmental degradation in space will cause some power loss due to micro-meteorites and proton radiation. Solar storms may cause severe damage to the cells.

GW

The results of the SPS system studies to date indicate that SPS's will be extremely reliable; these results must, of course, be regarded as very preliminary, and need confirmation by research and engineering tests on components and subsystems.

Carolyn Henson

US astronauts and Soviet cosmonauts have performed successful repairs on an Apollo command module (Apollo 13), Skylab and Salyut. Because SPS consists of many identical units in parallel, it will usually be possible to continue operation while technicians repair and maintain the satellite. There will be no lack of people vying for a chance to work as SPS technicians.

GD

Saboteurs could attack the receiving antennae, which would have almost indefensible perimeters of many miles, or the high voltage transmission lines.

Sen. Charles Percy

SPS would further legitimatize our spending vast amounts on orbital arms systems.

GW

As for vulnerability, **all** energy systems are vulnerable, especially foreign supplies. Almost any system *except* SPS is vulnerable to terrorist action. The idea that a terrorist could do much damage to an SPS receiving site recognizes neither the size nor redundancy of the receiving system.

An arms race in space, cited as one of the possible outgrowths of SPS, will tend to arise as a result of existence of strategic resources in space. Systems already in space have great military significance and the possibility of "war in space" has been discussed in the news media for the past few years. This is already a reality and I don't see it as very relevant to current or proposed SPS research.

MG

The largest potential environmental problems are related to the number of **space flights necessary to deploy an SPS.** The pollutants and exhaust from the rockets will create water vapor in the ionisphere, heating the upper atmosphere (greenhouse effect) as well as other possible problems.

The fuel is assumed to come from coal gasification plants. These plants, **according to NASA reports (my studies), may require up to 400** million gallons of water daily, 60% more than a city the size of Houston uses. These plants are still in the experimental stage, the environmental effects of their operation have not been fully considered.

GW

The engines contemplated for SPS launch vehicles will burn methane or hydrogen and oxygen. The principal exhaust product is water vapor, with significant amounts of carbon dioxide, carbon monoxide, and hydrogen. Nitrogen oxides cannot be produced in the primary combustion process because no nitrogen is present. Secondary combustion occurs as the rocket jet mixes with air; this process will produce some nitrogen oxides, but the amounts will be small by comparison to circumstances where the same quantity of fuel is burned with air in the primary combustion process.

If nuclear power plants are required to employ cooling water holding ponds, their land use is about equal to an SPS rectenna.

The total quantities of fuel required to place an SPS in geosynchronous orbit are roughly 850,000 tons of methane and 150,000 tons of hydrogen (plus about 3 million tons of oxygen). At an SPS construction rate as high as 2 to 4 per year, the fuels consumed by the SPS launch fleet (let's assume it operates out of the Kennedy Space Center in Florida) would be roughly equal to the fuels consumed by cars and trucks in Florida. Another way to evaluate SPS launch fuel usage rates is that the fuel consumption required to place one 10,000 megawatt SPS in space is about equal to the annual fuel usage of one 1000 megawatt fossil fuel plant. Thus, the total pollution burden, considering the **relatively clean combustion of the rocket engines, is very small. The issue has to do** with where the pollution goes— the rocket vehicles will deposit some of it in the upper atmosphere. Analytical studies are presently being conducted by the U.S. Department of Energy to determine the effects of SPS launch operations on the upper atmosphere.

MG

The receiving antenna requires large areas of land; the size is inversely proportional to the intensity of the microwave beam. A 10 GW SPS with an intensity of 20 milliwatts/cm^2 would need 2500 plus km^2, including an exclusion area. This is equal to 2/3 the size of Rhode Island. An SPS of this size would probably require 2 receiving antenna rather than one large area. These requirements present enormous land-use planning problems.

There is talk of utilizing the underlying land. This would be both impractical and uneconomical as the area would have to be completely shielded from the microwaves.

CH

Land under the rectenna is shielded from microwaves for the same reason you can't hear the car radio when you drive **under a concrete bridge: steel** reinforcement bars block out the radio waves. A metal grid open enough to let **through the short wavelength electromagnetic radiation we call "light" is a barrier to the longer wavelength radiation we call "microwaves" and "radio waves".**

GW

One such statement asserted that a NASA study "could find only 69 potential sites." Not mentioned is the fact that 69 sites would more than double the present total U.S. baseload electrical generating capacity.

As for launch vehicles, Boeing studies indicate that they can be operated from the current facility (KSC) to sustain an SPS construction rate of one per year. Ultimately, equatorial launch sites may be preferred. Preliminary studies have indicated feasibility of locating a floating launch site in international waters.

This is not to dismiss the land use problem. Rectenna siting **will** be a problem, but land use is a problem for all energy systems. The SPS land use is at least relatively benign.

SPS land requirements compare more favorably with alternatives than might be supposed. In the case of the SPS, the ground terminal itself (rectenna) requires a lot of area; in the case of most alternatives the support operations, e.g., mining, require a lot of area also. The only energy option that appears to be significantly less land-use critical than SPS is nuclear **power. If nuclear power plants are** required to employ cooling water holding ponds, their land use is about equal to an SPS rectenna. SPS's don't need cooling water.

MG

The U.S. microwave safety level is 1000 **times higher than that of the USSR: US — 10 milliwatts/cm^2, USSR — .01 milliwatts/cm^2. These standards are based on the effect on body tissue, while USSR standards are determined by the**

effect on the nervous system. The US standards will be redone by Dec. 1979.

What are the effects of direct exposure to a high-intensity microwave beam on birds, airplane passengers, air-borne species?

What are the consequences of long-term, low-level radiation on the whole population? Microwaves have been shown to cause central nervous system disorders, cataracts, genetic changes, and have been identified as possible factors of cancer development and Sudden Infant Death.

Microwaves may cause heating of the upper atmosphere by as much as 1000-2000° K, according to Fred Koomanoff of the DOE SPS program. This heating could cause local weather changes and possible larger scale climatic changes.

There is potential for interference with radio frequency systems because of the high power levels (gigawatts) of the beam. By heating the upper atmosphere and the formation of ion belts, the SPS could interfere with commercial radio and TV communications, radio and radar navigation systems, radioastronomy, amateur radio.

The receiving antenna captures 90% of the beam; 10% is dispersed by atmospheric particles. Areas of both low- and high-level microwave radiation can occur up to 500 miles from the receiving antenna. (This is why microwaves have not replaced power lines for terrestrial electricity transmission.)

GW

The use of electromagnetic radiation to transmit energy raises potential environmental issues. The effects of microwave-band radio waves on the atmosphere are well-understood and are essentially nonexistent. The effects of microwaves on the ionosphere, the extremely tenuous ionized fringes of the upper atmosphere, are less well-known. Significant concern has been expressed that the ionosphere would be disrupted by power beams. Recent experiments, however, indicate that the effects are much less than supposed by some investigators; neither thermal runaways nor instabilities were seen at simulated intensities twice those proposed for SPS use. These tests indicate that ionospheric effects will not be a detriment to power transmission; additional tests are needed to confirm this preliminary result.

The effects of electromagnetic radiations on living things are also of concern. The microwave power beam system currently proposed for SPS utilizes energy intensities too low to be of immediate physical danger. Further, the more intense region of the beam would be absorbed by a receiving antenna. The principal concern is related to long-term effects of the small amounts of beam energy that spill over outside the receiving area.

The spillover levels are within the range of experience of significant numbers of people exposed to the same kind of radiation from radio transmitters, microwave ovens, and other similar sources; nonetheless, before embarking on a large-scale program to transmit power from space by this means, one would wish to be considerably more sure than we are today that there really are no long-term, low-level, harmful effects. Thus, the research programs presently proposed for **solar power from space give major emphasis to environmental effects assessments as well as technology research.**

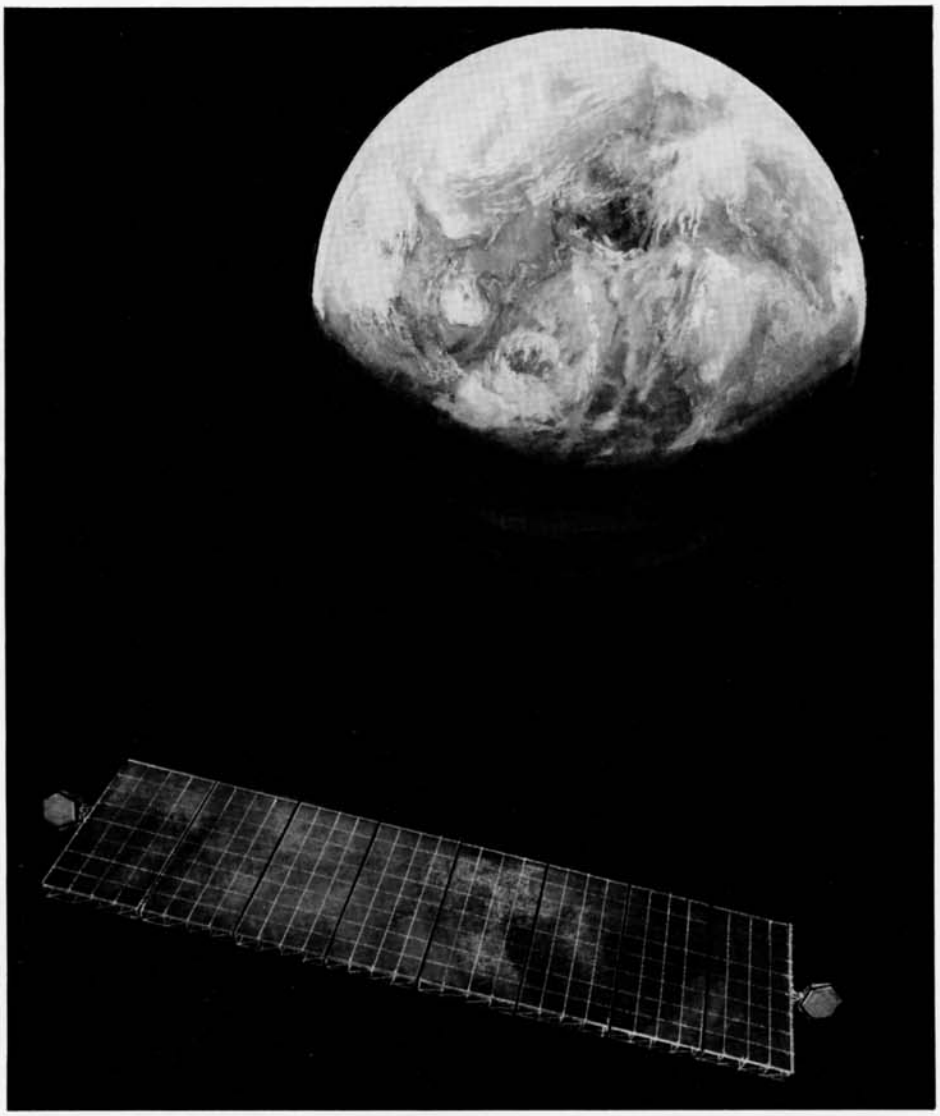
Environmental questions cannot be separated from the technology questions. The level of public exposure to microwaves from SPS's will depend on the technical performance of the beam control system. This can be measured in the laboratory once test hardware is developed. Thus, SPS environmental impact assessment depends on the accomplishment of a research program such as the one presently under consideration by the Congress.

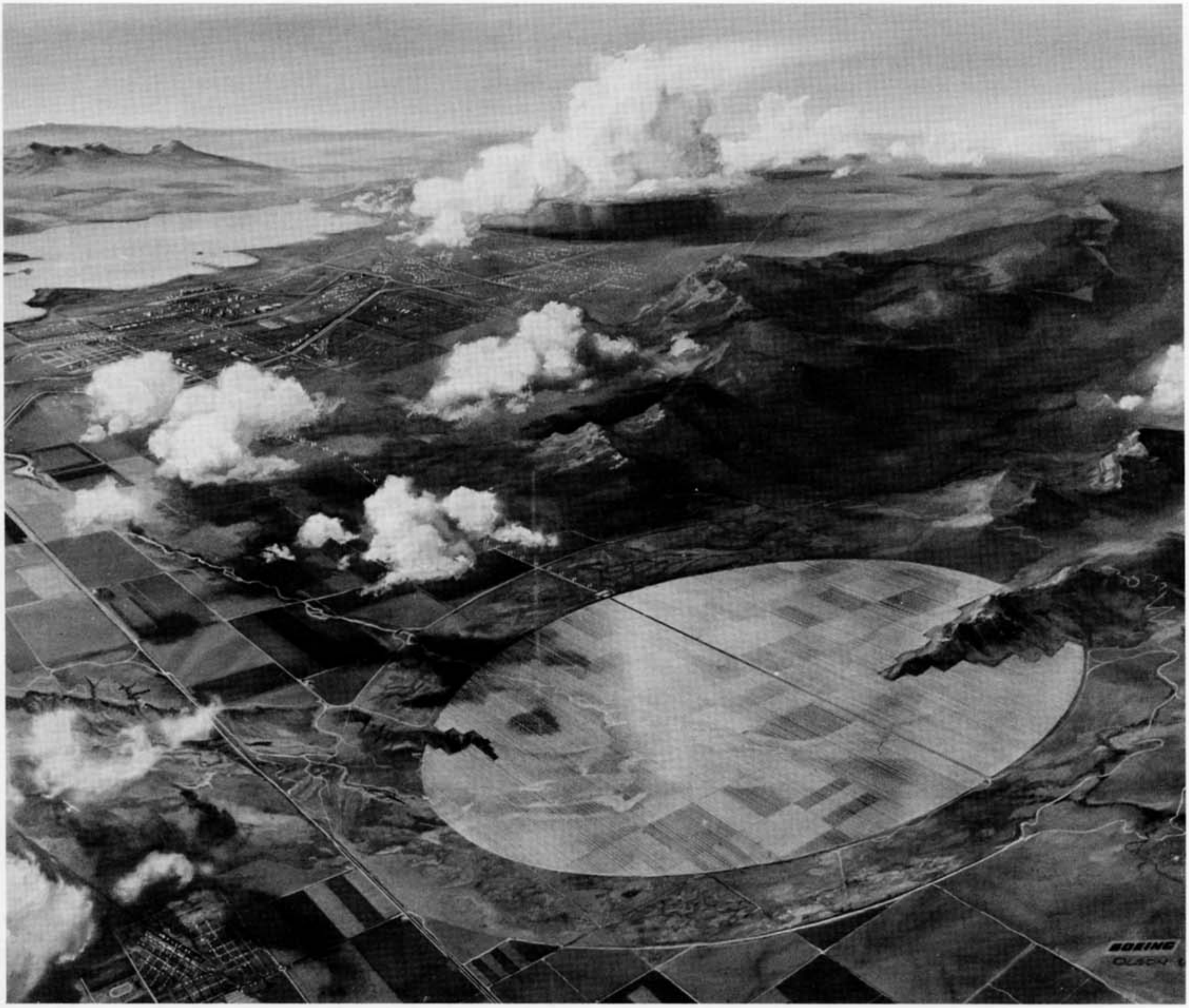
Depending largely on the outcome of assessments of the microwave environmental issue, SPS could turn out to be one of the most environmentally benign of the energy options presently considered possible, compared with the quantity of energy produced. This possibility alone is sufficient justification for the modest research program presently before the Congress of the United States.

CH

If the microwave transmission system is unable to meet environmental standards, laser transmission may be substituted. NASA and DOE are currently studying this option.

Is the debate over? Not yet! If you wish to join the SPS debate, send your statements and questions to Editor, L-5 News, 1620 N. Park, Tucson, AZ 85719.





The microwave receiving rectifying antenna (rectenna). The uncultivated area around it has been closed to human access in order to limit microwave exposure. Under the rectenna the microwave level is very low, allowing cultivation of crops.

A Solar Power Satellite Bibliography

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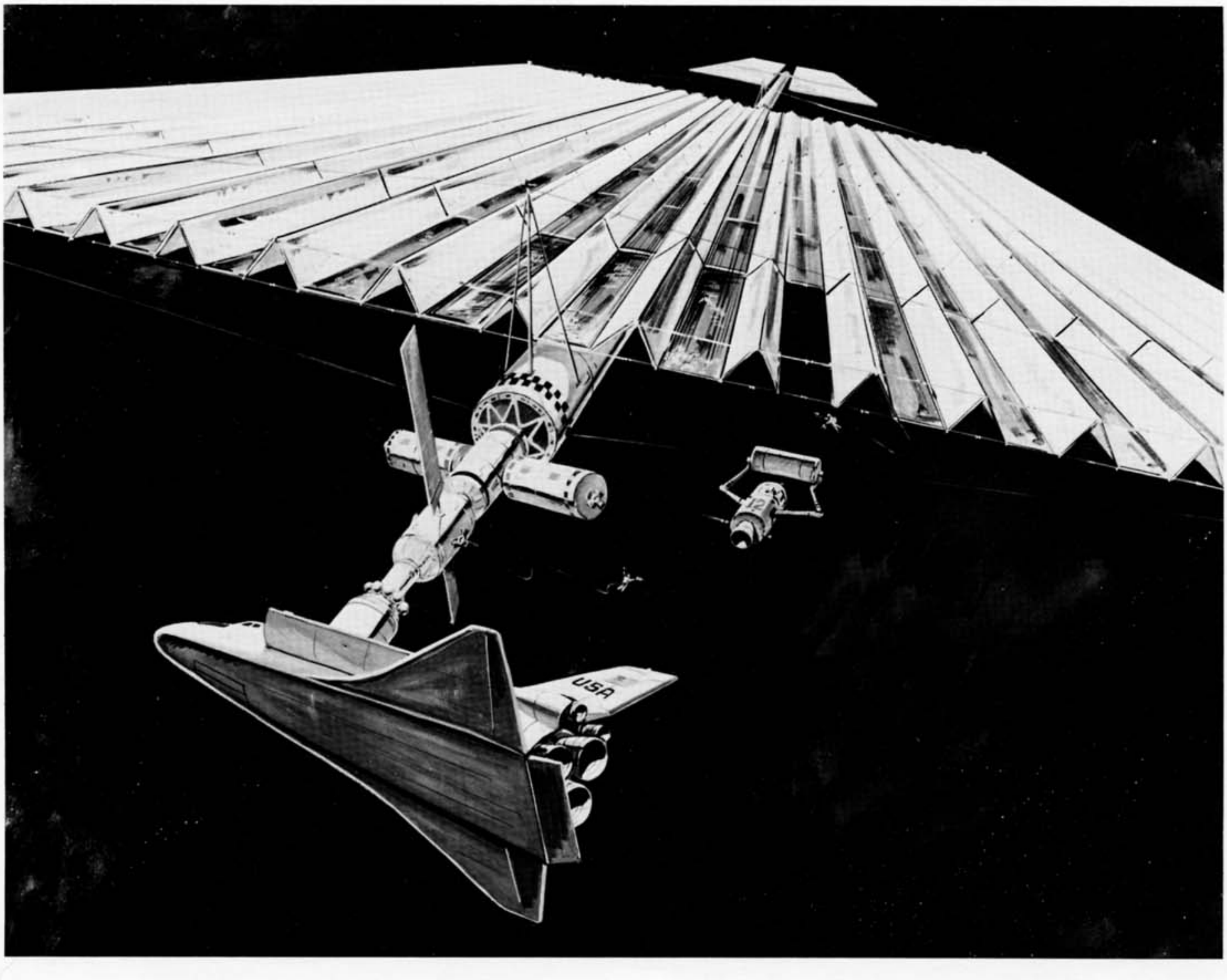
Solar power satellites, as this special supplement to the L-5 News shows, raise many unanswered questions. Will they aggravate the orbital arms race? Are microwave or laser transmission of power safe? Will they be able to deliver power at a reasonable price — and can we afford the initial investment? The list goes on.

What does the L-5 Society have to say about this? We believe that the nations of the world should face the energy problem by pursuing any and all possible solutions. At this date, we believe the SPS is a possible solution.

We won't get solar power satellites built by opposing other energy research projects. It won't give any credit to the New Space program if we become a mirror image of virulent SPS foes. We hope L-5 members will help set an example of how civilized people go about solving a problem: look at all the alternatives, study them carefully, do some tests, and make decisions without resorting to insults or hyperbole.

SPS may flounder in a morass of technical, environmental or economic problems. Or it may provide Earth with large quantities of cheap, clean power. We don't know yet. But the cost of finding out is small compared to the benefits it could bring.



A demonstration solar power satellite. It could be built before 1985.

NEWS BRIEFS

Egypt to Put Small Payloads Aboard Space Shuttle

The Egyptian government has reserved four small self-contained payloads to be flown on the Space Shuttle in the 1980 s. At a NASA headquarters ceremony held last July 13, Dr. Mohamed Shaker, Minister of the Embassy of Egypt in Washington, D.C., and Dr. Farouk El-Baz, Research Director for the Center for Earth and Planetary Studies, Smithsonian Institution, presented NASA officials with a down payment to reserve Shuttle space.

The payloads, commonly called "getaway specials," can weigh no more than 90 kilograms and be no larger than .5 cubic meters. They are flown on the Shuttle on a space available basis for scientific research and development purposes.

The Egyptian purchase marks the first foreign educational use of the payloads program. Egyptian students will compete in a nationwide contest by submitting proposals for an experiment to be flown aboard Space Shuttle missions. Evaluation of the proposals will be under the direction of El-Baz.

Far-Out Crime

If the US media has any impact on its nation's criminals, the "forcible financing" of space colony construction may become as popular as hijacking once was.

It all started when Steven Masover, 19, held up a bank in Menlo Park, California last November. Apprehended with $78,000 in cash, an unloaded gun, a fake bomb, and three hostages, it looked as if Masover was slated for a long stay behind bars. However, when his trial came up, he told the jury that he had only borrowed the money in order to invest it in a space colony, and claimed he had planned to pay it back in 20 years or so.

The district attorney made the mistake of claiming that investing the loot in space colonies would be "permanently depriving someone of their money, in common horse sense". The jury, apparently believing otherwise, freed Masover.

Masover was recently awarded a scholarship to attend the University of California at Berkeley where he plans to study physics.

And . . . in case you were wondering . . . no, Masover is *not* an L-5 member.

LA Space Capitalists Form Investment Club

On October 13, 1978 the Space Development Company was officially formed, following two months of preparation. The purpose of the partnership is to accumulate sufficient capital to undertake the serious industrialization of space.

When we began discussing private investment in space industrialization and settlement, we were faced with a difficult question: how can a group of small investors become involved in a one hundred billion dollar enterpise? The Space Development Company is our answer to that question. As an investment club, we can pool our resources immediately, and evolve into a corporation as our assets increase. In the short term our main activity will be to expand our assets through wise investments and additional capital subscriptions. Determining the specific steps from an investment club to an operating company will require more research and discussion.

As the company grows, we want to consider many options for developing space. We also want to offer whatever assistance we can to others who are interested in starting their own investment groups. If you have any suggestions, or if you would like to find out more about our club, write to; Terry C. Savage, SDC Agent, 1900 Dufour, Apt. 16, Redondo Beach, Ca. 90278.

Please note: this is *not* to be construed as an invitation to join the Space Development Company. It is a *private* partnership.

Carter Announces Space Policy

"No news is good news" say veteran Carter watchers in the aftermath of his Oct. 1 speech in Cocoa Beach, Florida. Some space program boosters were upset by a **Los Angeles Times** article which reported that "The National Aeronautics and Space Administration's budget, now $4.3 billion, may shrink significantly . . .". However, a close examination of this speech and a press release dated Oct. 11 reveal that the "new" Carter space policy is mostly more of the same.

In Cocoa Beach Carter told the audience, "I am often asked about space manufacturing facilities, solar power satellites and such other large scale engineering projects. In my judgement it is too early to commit the nation to such projects. But we will continue the evolving development of our technology, taking intermediate steps that will keep open possibilities for the future."

However, Carter made no commitment to any specific intermediate steps such as technology development on the ground, assembly of structures in space, or a space power module.

The October 11 press release, the "White House Fact Sheet on US Civil Space Policy", went into more detail. "It is neither feasible or necessary at this time to commit the US to a high challenge space engineering initiative comparable to Apollo . . . . It is too early to make a commitment to the development of a satellite solar power station or space manufacturing facility due to the uncertainty of the technology and cost/benefits and environmental concerns. There are, however, very useful intermediate steps that will allow development and testing of key technologies and experience in space industrial operations to be gained. The US will pursue an evolutionary program that is directed toward assessing new options which will be reviewed periodically by the Policy Review Committee. The evolutionary program will stress science and basic technology integrated with a complementary ground R&D program — and will continue to evaluate the relative costs and benefits of the proposed activities."

So, while Carter may not have come up with anything new, at least he hasn't tried to close the door on our dreams.

Inside the L-5 Society

High Schools Debate Power Satellites, Space Colonies

Across the United States thousands of high school students are avidly researching and orating on the space colonization concept. This year's high school debate resolution reads: "Resolved; that the federal government should establish a comprehensive program to significantly increase the energy independence of the United States." Of course it was not long before many of the more enlightened debate teams realized the potential of space colonization and power satellites under the imperatives of the topic. The participation of high school students in discussions on space will help further the goals of the L-5 Society by involving some of the people most likely to be in L-5 by 1995 — today's high school students.

We hope that the members of the Society will take interest in the attempts of debators promoting the L-5 ideal by tailoring your remarks on the subject to encompass discussions on how a program of space development could significantly increase (the energy independence of the U.S. Articles in **L-5 News** and popular magazines on the subject are of the greatest benefit as they are easily available to most high school students. Researchers, including ourselves, will be attempting to contact many supporters of the colonization effort and attempt to find elusive evidence that we might not uncover elsewhere.

If by chance you are contacted by a debator (an example: during the Redlands University Debate Institution, over the summer ourselves and a friend, Paul Munch of Pomona, California, attempted desperately to arrange a phone call to Professor O'Neill) they would appreciate your cooperation in helping them develop a better knowledge of space power concept through acquiring **printed** and **published** documentation that you as "insiders" on the progression of the effort might have available.

Most debate teams have chosen to use the O'Neill plan as the basis for their proposals in debate rounds. Some of the problems that need to be addressed to make advocacy of space colonization easier for debators are:

1.) Are we really ready to progress in a development program within the time scale that O'Neill provides? Or should we opt to only study the problem some more and then go ahead with a development effort without making any commitment to space at the present time?

2.) Would an international plan be better than the national plan discussed in this year's debate resolution? What do the proponents think? Would Professor O'Neill would want his concept adopted through the structure of the debate resolution or would he prefer an international development scheme? (Needless to say, because of the insistence of most debate teams using space plans to defend the specifics of the O'Neill plan to the letter, it would be most useful if the professor himself could make statements concerning the applicability of his concept to the high school debate topic.)

3.) Is there a distinction made by experts between ground launched satellites and colony manufactured ones? Too many times teams advocating the O'Neill concept are losing rounds because of evidence read that only applies to ground-launched SPS, (i.e. that SPS would create climatic disturbance from launches, that SPS costs 1/2 trillion dollars, etc. . .)

Many L-5 members will hear from us this year and we look forward to our earnest effort to sincerely advance the space colonization movement through the medium available to us . . . debate. Inquiries on the subject, helpful offerings of evidence showing colonization's effectiveness under the debate resolution, and other members of the society who are debators and would like to correspond with your forensic comrades can write to us at: 465 Riviera, Turlock, Cal, 95380.

Matt George & Michelle Richardson
Captains of Debate, Turlock High School

P.S. We were just informed that the collegiate debate topic also has space colonies as an option, (their topic deals with providing employment opportunities) and that further inquiries and info on the subject should be obtained and sent to: Cindy Fraliegh, 9021 Sutters Gold Drive, Sacramento, Ca., 95826.

Slide Recall

No, you don't *have* to return any of your slides. However, if you bought slide A36, you can trade it in at no charge for a better version of that slide.

Nova Scotia L-5

We would like to inform the Society that we have recently formed the Nova Scotia chapter of the L-5 Society. Officers for 1978 are as follows:

President: Dr. Hugh A. Millward
Secretary: Mr. Michael Oja
Treasurer: Mr. Dennis Doof
Our address for correspondence is:
Nova Scotia L-5 Society
c/o Department of Geography
Saint Mary's University
Halifax, N.S.
B3H 3C3
Canada

Please note the new address for Houston L-5: Box 10161, Houston, TX 77206.

Virginia Tech Speakers' Bureau

If you live in the Blacksburg, Roanoke and Richmond, Virgina areas and need a speaker on space settlements, contact David Jones, VA Tech information officer, 711-9 Townside Rd., Roanoke, VA 24014.

Space Futures Newsletter

The Philadelphia based Space Futures Society has inaugurated the **Space Futures Newsletter** with a twelve page November issue. It contains news items on Landsat, O'Neill's Space Studies Institute, the Soviet space shuttle, Venus probes and more. The newsletter is free to Space Futures Society members. Dues are $10 per year, $5 for students. Send them to 1627 Spruce Street, Philadelphia, PA 19103.

Canadian Lecturer

Alan R. Hildebrand, of the Royal Astronomical Society of Canada, is available to give lectures on space settlements. He can be contacted at RR 7, Fredericton, NB Canada E3B4X8, 506/363-2050.

Errata

We've piled up a few lately — is our face red over listing a UCLA L-5 (**L-5 News,** October 1978). It's at arch-rival *USC*, care of John Blanton, Box 77206, Los Angeles, CA 90007.

In "Careers In Space" (**L-5 News,** August 1978) we tell Houston area students to contact the Physics Dept. of Rice University. That's the *Space Physics Dept. and Astronomy Dept.*

SPACE - ORIENTED INDIVIDUALS are invited to send resumes for eventual consideration for employment with wide ranging project. We anticipate several job openings in the coming year. No aerospace or technical background required. All fields welcome. Send to: Sabre Foundation, Earthport Project, 221 W. Carillo St., Santa Barbara, CA 93101.

So You Want to Write for the L-5 News?

We welcome articles for the **L-5 News**. Pay is rotten: two extra copies of the issue carrying your opus, and your own personal press card.

However, indirectly your L-5 press card can be worth a great deal. It will get you free admission to almost anything, free photos, papers, press releases, you name it. It's up to your discretion where you go and how you use it.

If you have ever written for the **L-5 News**, or sent us photographs or artwork we've used, you can get a free personalized press card by writing in and requesting it. If you haven't written for the **News** yet but know of an event where you could obtain useful information, we can also supply you with a card.

If you need "freebies" to butter up someone for an interview or to obtain free admission or photos and artwork, let us know and we will help you out.

If you've never written for the **L-5 News** before, but would like to, here are some tips:

1) Fill the article with *facts*. If you're a rotten writer but can dig out the *facts*, we'll sweat over your article until its ready to print. If you send in an opinion piece, however, you've got to write like an angel.

2) Don't use no double negative.

3) Make each pronoun agree with their antecedent.

4) Join clauses good, like a conjunction should.

5) About them sentence fragments.

6) When dangling, watch your participles.

7) Verbs has to agree with their subject.

8) Just between you and I, case is important to.

9) Don't write run-on sentences they are hard to read.

10) Don't use commas, which aren't necessary.

11) Try to not oversplit infinitives.

12) Its important to use your apostrophe's correctly.

13) Proofread your writing to see if any words out.

14) Correct spelling is esential.

Happy writing—CH

Editor Wanted

Do you cringe at the choice of articles, writing style, layout and artwork in the **L-5 News**? Could you do any better? Yes? Well, then we have a job for you. You can become the editor of the **L-5 News**—if you can stand to start at $500/month and can convince me you can handle the job.

Would you print an article about a heat machine with no cold sink? A reactionless drive? Can you turn a well researched but hideously written article into a literary gem—without offending the author? Can you turn 15 different items that came in the mail into a coherent news item? Can you check facts, and, if you later discover a boo-boo, tell everyone about it in the **L-5 News**? Would you be willing to go out of your way to solicit news, articles, photos and artwork?

What would you do if the printer said they're too busy and the **News** will be printed a week late? If the typesetter suddenly goes out of business? If the paper company is on strike?

If none of these questions faze you, write or call Carolyn Henson, 1620 N. Park, Tucson, AZ 85719 or 602/622-6351.

Letters

Skyhook Reply

The observations about rotating skyhooks made in Dr. Brakke's letter to **L-5 News** are correct, but not all his assumptions are the same as mine.

My analytical calculations assumed the skyhook remained straight to keep the problem tractable, but I never expected it to remain perfectly so in actuality. Not mentioned in the L-5 article were a series of digital simulations of both graphite terrestrial and Kevlar lunar skyhooks. These modelled the hooks as a string of a few hundred point masses separated by springs, to reflect the density and modulus of elasticity of the materials. The simulations showed that the cable did bow when it was horizontal (the ends dipped below the middle), but the angle was less than 5 degrees. There was also a 1 percent change in elongation between the horizontal and vertical orientations. These effects don't impair the skyhook's utility and lateral stiffening is unnecessary.

Damping is necessary. My simulations included both undamped and heavily damped cases. Captures or releases in undamped skyhooks inevitably launched tension/compression waves which travelled to the other end of the hook over

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L-5 SOCIETY MEMBERSHIP FORM (please type or print)

NAME: ______________________________

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CITY/STATE/ZIP: ______________________________

AFFILIATION/TITLE OR POSITION ______________________________
(OPTIONAL)

I am____ am not ____ interested in being active locally. Phone (optional) ______________

____ Please enroll me as a member of L-5 Society ($20 per year regular, $15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of $12/year included in membership dues).

L-5 Society members who sign up for the Space Legislation Hot Line option receive frequent first class mailings on the actions of Congress and the President which affect the space shuttle, space colonies, solar power satellites, space exploration and other space projects.

____ Sign me up for the Space Legislation Hot Line.

L-5 Society
1620 North Park Avenue
Tucson, AZ 85719

several minutes, where they reflected and reinforced themselves and snapped off a piece of cable. In the damped cases the waves were sufficiently attenuated to be negligible when they got to the other end. Surprisingly, undamped skyhooks didn't run into trouble as long as the masses at their ends were not altered (i.e. no captures or releases).

Your observation about varying rotation rates is correct, but the situation is even more complicated, because the extended skyhook does not orbit exactly like a point at its mass center, as the analytical derivations assumed. At touchdowns the downward half of a symmetrical cable pulls down more than the upward half pulls up, and thus the mass center momentarily falls. This is actually an advantage because it lowers the takeoff acceleration, and thus the force on the cable in this maximum stress orientation. The elongation changes add yet more complication, and adding and removing masses really screws things up.

By experimentation I've managed to tweak skyhook lengths and initial conditions so that they nearly touch down six times per orbit, if you don't spoil things by adding payloads. The parameters are different from the analytic initial approximation in about the third decimal place.

Operating a skyhook transportation system will obviously keep several computers pretty busy calculating either the minor corrections needed to keep the skyhook in place and on time, or else predicting where it will show up so that a small rocket ferry can rendevous with it.

Regarding your and Carolyn's comments on metallic hydrogen, I don't think the evidence is in yet. It may be metastable like diamond or nitroglycerin. The linear theories that apply to normal pressures and densities can't be trusted at the 2 million atmospheres needed to make metallic hydrogen. Nobody is willing to guess about its stability, and you couldn't believe them if they did.

Hans Moravec
Artificial Intelligence Lab
Stanford University
Stanford, CA

SPS Pro & Con

You should try to show antinuclear people the potential of space power stations. I don't agree with Woodcock that nuclear foes are "irrational". I live where they mine it — it isn't safe or clean.

Anonymous
Niwot, CO

I would like to make a comment about Ken McCormick's article on the Solar Power Satellite Hearings.

It seems to me that Senator Abourezk should immediately be taken to the nearest hospital in the attempt to save himself from an almost sure to be fatal dose of Foot-in-Mouth disease. His comment about the 'Sunsat' group is direct evidence of a well advanced case. He says that 'Sunsat' is controlled by General Electric, McDonnell Douglas, Grumman, et al, and that if they get control of the SPS then they will, in effect, control our energy resources. He finished by saying: "Massive government regulation would be necessary to protect the consumer."

Now maybe I've missed some of his logic somewhere, but if I recall correctly, all of these companies are American run organizations and this would seem to be much more preferential over the Middle Eastern control that we now have. In fact isn't this return to American control exactly what we have been preaching about? At least then we would have that option of government controls if it were needed, whereas this control is not possible now as we can see everytime we pull into a gas station.

Larry D. Evans
Fairchild, WA

I am one of those who joined L-5 after the **Playboy** publicity, somewhat out of curiosity but mainly out of concern for our energy situation. Colonies and industry in space might work out, but the solar power satellite won't.

At one time I believed the solar power satellite was a good idea, but that was before I discovered what it *really* is: a multi-billion dollar corporate scam that affords the multinationals traditional objectives: monopoly and big, big profits.

Not to mention the radiation hazard (we'll cook more than geese), and other environmental problems (the incredible influx of energy will ultimately result in waste heat, and we're already warming the planet frighteningly fast).

The solutions to the energy problem must be economical, safe, decentralized, and democratically controlled. Solar power satellites are none of these.

Kevin Gillooly
Columbia, MO

Space Colony Course

I was disappointed not to find my courses on space colonies among those listed in **L-5 News** (page 9, August 1978). I suggest that I have taught about the colonization of space longer than anyone other than Professor O'Neill, since I was teaching a course called The Space Venture when O'Neill's Physics Today article was published, and I incorporated the topic in my course that fall. A brief discussion of my experience was published in **L-5 News** (page 6, December 1975). A full article describing my experiences in teaching about space colonies will be published in the American Journal of Physics this spring. I shall send the reprints (gratis) to the L-5 Society for distribution.

Jay S. Huebner
Department of Natural Sciences
University of North Florida

Pipefitters Passé?

I must say that I find Jack's advice for our editor's daughter (Sept. L-5) typical of him but, in this case, totally wrong. Let her become multi-disciplined—a generalist. For it will be the generalists who will live in the space habitats; not the specialists who will be needed only on a temporary basis. It will be the generalists who will be able to adapt to a new and constantly changing environment where the unexpected will happen daily and makeshift will be the password.

David Jones
Va. Tech Chapter
Blacksburg, VA

Feel What Can't Be Said

It's not enough to just live, on a minimal survival level. We have to ensure that more than abundant life that we are promised, in God's word, and to do that we have to have faith, and to look up. There may be, one day, nowhere to go but up.

Leora E. Morey
Medford, OR

Look Up

We need colonies for the same reasons the Egyptians created the pyramids: for the jobs, the feeling of togetherness and creativity, and so that others may look back thousands of years and feel what can't be said.

Michael C. Emmert
San Antonio, Texas

L5 NEWS

December 1978

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY
VOL. 3 NUMBER 12 DECEMBER 1978

In this issue:

1 **Ra-Shalom** *According to space farm expert John Phillips, the recently discovered asteroid Ra-Shalom contains enormous amounts of nitrogen, hydrogen, and carbon, building blocks of life not found on the Moon. Orbiting near the Earth, Ra-Shalom or asteroids like it may make large, life and water rich habitats feasible in the relatively near future.*

2 **IAF Conference** *Frederick H. Osborn, Jr. reports on the largest international space conference of the year. Interesting highlights are the debates over geosynchronous orbit and the USSR's favorable reception of the solar power satellite concept.*

7 **Theatre for the Future**

8 **Golden Sheep Drop Honors Cheap Shots** *Houston columnist Donald Morris has a comeback for "Darth" Proxmire's Golden Fleece awards.*

When in Washington DC Explore the Planets

9 **NASA Squelches US/USSR Cooperation Talk** *Recent rumors of Soviet willingness to rescue Skylab has prompted a "keep your mouth shut" dictum to NASA employees who object to the US decision to let Skylab crash.*

Copernicus Finds Second Black Hole

10 **Astronaut Candidates Learn Water Survival**

11 **Mining the Moon** *William N. Agosto shows that lunar materials contain significant amounts of easily recoverable free metals.*

12 **Carter Sets Space Policy**
Carter's Pilgrimage to the Stars
In this pair of articles Leonard David tells us where Carter's space policy is headed.

14 **Announcements** *The 4th Princeton/AIAA Conference on Space Manufacturing is looking for papers. And $102,000 in prize and scholarship money is looking for you!*

15 **Congress Views Space** *Paul J. Werbos gives amature lobbyists advice on how to make points with the US Congress.*

US Space Legislation Roundup *In 1978 Congress appropriated more money to the New Space Program than NASA had originally requested. Space boosters take heart!*

17 **Inside the L-5 Society**

18 **Letters**

Cover: Artist's concept of a lunar mining base. The four horizontal cylinders contain the base habitat, maintenance facility, soil packaging plant, and loading facility. For details on obtaining free metals from the lunar soil, see "Mining the Moon", by William N. Agosto, page 11. *(Artwork courtesy NASA.)*

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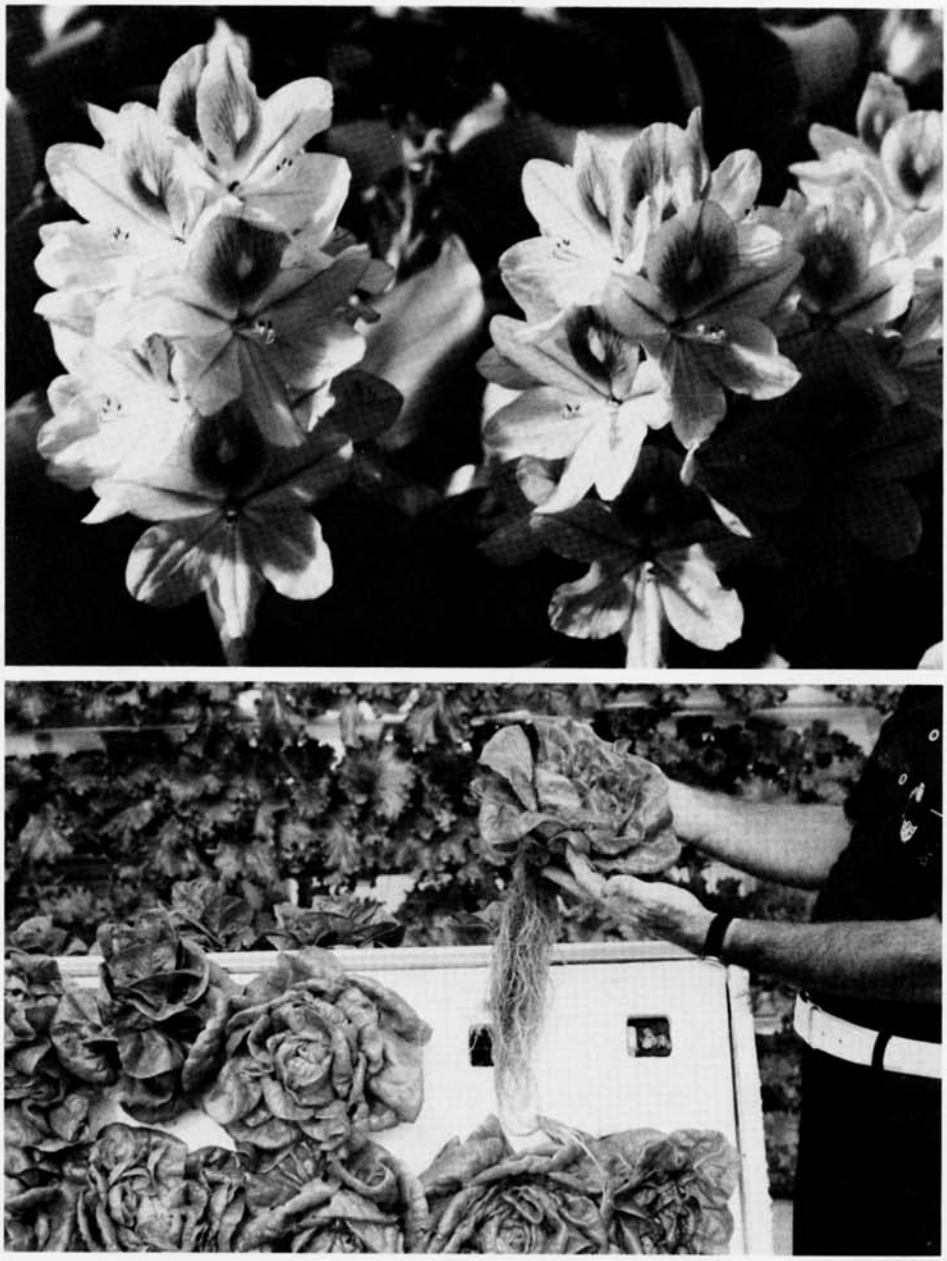
RA-SHALOM

Name of Newly-Discovered Asteroid Honors Camp David Peace Conference

by John Phillips



Above: water hyacinth plants can aid in an aquatic wastewater recycling system by concentrating toxic heavy metals. Below: lettuce is grown without soil, under space farm conditions.

A team of scientists led by Dr. Eleanor Helin at the California Institute of Technology recently reported the discovery of a large, Apollo class asteroid which may be of the carbonaceous chondritic type. The find may prove to be highly significant for any possible future program of space industrialization.

Asteroids represent an alternative to lunar resources as a supply of raw materials for space manufacturing enterprises. The carbonaceous chrondritic type are of special interest due to the presence of significant quantities of nitrogen, hydrogen, and carbon, elements required to establish life support systems for space settlements. If these elements can be obtained from extraterrestrial resources, lift costs to bring them from Earth can be avoided. This would enhance the economics of space industrialization considerably. Furthermore, the use of extraterrestrial sources of life support system elements removes major constraints in the design of such systems.

Assuming an abundance of nitrogen, hydrogen, and carbon will be available from processing carbonaceous chondritic asteroids, life support systems can now be designed around extended food chains. Abundant supplies of foods derived from traditional agricultural and livestock species can be anticipated. System stability and reliability can be assured by designing redundancy into the space farm. Surplus production can be stored, and some might even be shipped to outposts too small or temporary to jusify having their own agricultural systems. Most important, life support systems need be only partially closed with respect to recycling of materials. Toxic heavy metals, for example, can be concentrated by water-hyacinth plants, shown above, in an aquatic wastewater recycling system. The dried plants can be processed through an incinerator and the ash containing the heavy metals can be jettisoned or sent to the space manufacturing facility as raw material.

Eleanor Helin has given the newly found asteroid the name "Ra-Shalom" in honor of the Camp David Peace Conference. "Ra" is the name of the Egyptian Sun-god, symbol of enlightenment. "Shalom" is the traditional Hebrew greeting meaning "peace". Many individuals involved in the space settlement and industrialization movement have commented that this enterprise may well be the key to achieving peace on Earth. As we all look forward to the Christmas holidays this year with raised hopes that peace might finally be achieved in the troubled Middle East, we can also reflect upon the discovery of Ra-Shalom and hope "Ra-Shalom, shalom aleichem," which is to say, "Ra-Shalom, peace be with you."

International Astronautical Federation Conference

by Frederick H. Osborn, Jr.

Garrison, N.Y. - October 13, 1978. Sunday evening October 1 upwards of eight hundred registrants at the XXIXth Congress of the International Astronautical Federation (IAF) filed into the festively decorated conference hall of the Libertas, the prestige hotel of Dubrovnik, Yugoslavia. While the Ansambl Dubrovnik Folk Band played at the south end of the room, the registrants from thirty nations passed down the receiving line, shaking hands with Tatomir Andjelic, President of the Yugoslav Organizing Committee for the Congress, and Marcel Barrere, President of the IAF. Large tables loaded with native canapes filled the center of the room, and in each corner stood a well-tended bar. Near the north end, four excited students winners of American Institute of Aeronautics and Astronautics awards, shook hands and shared hugs with Soviet Cosmonauts for the benefit of the press and swarms of amateur photographers. Small groups gathered and dispersed throughout the room, being photographed, performing introductions, renewing old acquaintances, or just conversing. It was a warm and friendly scene.

Monday morning President Barrere presided over the formal opening ceremonies in the same hall. This time the registrants were seated. Most of the 816 were there, 526 participants, 147 observers, 41 students, 82 representatives of the press (50 from Yugoslavia, 32 from other countries), and 20 members of organizing committees. They came from 30 countries and the United Nations, 189 from the United States, 115 from Yugoslavia, 97 from France, 89 from West Germany, 71 from the Union of Socialist Soviet Republics, 22 from Italy, 15 from Japan.

Andjelic, his face as craggy as his native Dalmatian mountains, and Monsieur Barrere, who is as round and stocky and French as Andjelic is tall and spare and Balkan, gave welcoming speeches. So did Dr. Ikonic (on behalf of President Tito), Drs. Valjalo and Perek, and the Honorable Peter Jankowitsch.

The theme of the Congress, as proclaimed in large white letters on a blue banner hanging on the east wall, was **"ASTRONAUTICS FOR PEACE AND HUMAN PROGRESS."**

XXIXth Congress of the International Astronautical Federation, Hotel Libertas, Dubrovnik, Yugoslavia, October 2, 1978. At the rostrum, delivering a speech of welcome is the Honorable Peter Jankowitsch, Austrian Ambassador to the United Nations and Chairman of the United Nations Committee on the Peaceful Uses of Outer Space. Seated l. to r. Dr. Lubos Perek (Czechoslovakia), Chief of the Outer Space Affairs Division of the United Nations, and Dr. C. Stark Draper (USA), President of the International Academy of Astronautics.

Following the welcoming speeches, Academician Leonid I. Sedov, a distinguished, graying gentleman with heavy glasses and courtly manner, delivered the 9th IAF invited lecture on the subject of "Astronautics for Peace and Human Progress."

He spoke of photographs of the far side of the Moon and of the human presence in space. He told us that space efforts included attempts to end pollution and that space science offered the possibility of eliminating hunger from certain parts of the Earth. He proposed that space achievements can take partial credit for the world being without a major war for 30 years. Space safety is being developed. We have landed on the Moon and have landed probes on Venus. International cooperation is becoming increasingly important because of the depletion of Earth resources, the power crises, etc. Scientific outposts in space should continue to be developed, as should radio and communications, weather and hurricane forecasting, and geographic research. He maintained, however, that many of these activities will have to be regulated.

During the opening speeches, which were in Serbo-Croatian, French, English, and Russian, simultaneous translation was provided through individual transistorized receivers equipped with earphones like those passed out on transatlantic flights. At the end of Academician Sedov's lecture, which was in Russian, President Barrere announced that the language of the Congress would be English, and turned the meeting over to Dr. George E. Mueller (USA), former Director of Space Flight for NASA, who chaired a Forum on ongoing space activities.

Dr. Roy Gibson (Britain), Director General of the European Space Agency (ESA), and soon to become IAF President, was the first speaker. He reviewed five areas of European space activity. First, there is the scientific, as exemplified by GEOS II which flies with a European-built attitude control, the IUE (International Ulta-violet Explorer) which will be launched January 26, the NASA space telescope for which ESA is furnishing the faint object camera, the EROS infra-red satellite, which will be launched in cooperation with the Netherlands in 1981, and OTS II (Orbiting Test Satellite) which has been in orbit since February. Next he reviewed communications, as exemplified by PCS I which will be flown in 1981 and PCS II a year later, both owned and operated by EUTELSAT. The third area reviewed was observation, as exemplified by MAROTS, the European Maritime Communications satellite. Fourth was Spacelab, which has a $650,000 budget in 1978 and which, he said, generates two monetary units in business for every monetary unit raised through taxes and contributions. Lastly, he reviewed the development of European launch capability through the Ariane Project which is expected to make its first test flight in 1979 from French Guiana. Funding is assured and the work is progressing well.

XXIXth Congress of the International Astronautical Federation, Hotel Libertas, Dubrovnik, Yugoslavia, October 2, 1978. Left to right, Marcel Barrere (France), President of the IAF, Tatomir Andjelic (Yugoslavia), President of the Yugoslav Organizing Committee,Leonard Jaffe (USA), past President of the IAF, Leonid I. Sedov (USSR), Vice President of the IAF.

ESA, Dr. Gibson said, is a cooperative venture which includes other than member states and is as much of interest to underdeveloped countries as to those with space capability. ESA's biggest problem, he revealed, is money, which is much scarcer than good ideas.

In closing, Dr. Gibson urged removal of artificial barriers to international communication and quoted a Latin inscription in the upper gallery of the rector's palace in old Dubrovnik (the rector was, in effect, the mayor in medieval times). Freely translated, it reads: "Forget what is good just for you. Think about the general well-being."

Academician Boris N. Petrov, Chairman of the Inter-Cosmos Council of the USSR, and Chief of the USSR delegation to the IAF, spoke next. He said that the USSR attaches great importance to cooperation with other countries and that the USSR is getting ready to launch a second satellite for India. He showed a number of slides illustrating various scientific aspects of the Soviet space program.

Your correspondent lunched in the "Old City" of Dubrovnik, one of the few walled medieval cities still intact. Its five hundred year old buildings, on streets often less than six feet wide, are surrounded by a towering wall encrusted with glowering guard houses and battlements. Fantastically picturesque, it is a living example of how hard life was for our ancestors and, consequently, a splendid launching pad for space-related hopes for our descendants.

Monday afternoon there were 5 simultaneous sessions with 30 scheduled papers on subjects ranging from "Scientific Goals and Technical Realization of Near-Earth Experiments by Members of the Cosmic Physics Working Group Within the Intercosmos Cooperation" by Dr. H.J. Fischer of the Academy of Sciences of DDR (Deutsches Demokratische Republik) to a survey of "Space Flight Safety Systems" by N.E. Brown of ORI, Inc., Silver Springs, Maryland.

The formidable schedule of 5 sessions every morning and afternoon continued (except for a recess Wednesday afternoon) all week for a total of 46 sessions on twenty subjects at which more than 500 authors presented some 345 papers. To cover it all was physically impossible. English was the language of the Congress, but many of the efforts at translation from Slavic and Oriental and some of the European languages were beyond comprehension. A Norwegian police chief, for instance, in the Safety and Rescue Symposium, quite unwittingly introduced a religious note when his translator called rescues "salvations"! Japanese attempts to "raunch saterrites" would have been hilarious if the delivery were not so strained and sincere as to melt the heart. On the buses which shuttled between the half-dozen hotels that housed the participants it sounded like the Tower of Babel.

Supporting the general sessions, which were held in six areas of the Hotel Libertas, were administrative meetings, committee meetings, meetings of IAF member societies (there are 58 of them), the International Academy of Astronautics, the International Institute of Space Law, the International Programme Committee for the XXIXth Congress, the Yugoslav Organizing Committee for the XXIXth Congress, the Ladies Committee, plus press conferences, receptions, and special meetings of varying degrees of formality. No wonder almost everyone was exhausted by the end of the week!

Principal media coverage for the Congress was **The Reporter**, an eight page illustrated daily in English (the back page was Serbo-Croatian) put out by an intelligent and remarkably energetic crew of young Yugoslavs. Some of the grammar was quaint (on the masthead: "cliches made by. . .") but on the whole it was an excellent paper.

At 5:30 Monday afternoon the first current events session was held. It was a USSR report on Salyut 6. Lasting two hours at the end of an arduous day, it was almost more than mind and body could bear. Russian spacemen are not orators. They are not showmen. They are plodding persistent, dogged, determined doers. They are fascinated by the space program. They have the enthusiasm that our youngsters have for it, and they want to tell everyone all about it, down to the last infinitely insignificant detail. Academician Petrov led off in Russian. Every few sentences there was a pause for translation. He introduced a galaxy of cosmonauts, engineers, and academicians. Upon introduction each star rose to his feet. There was applause. The applause drowned out the interpreter, so we never knew who the rising stars were. Then Petrov sent a string of cosmonauts to the rostrum to tell about their experiences in

Salyut, a Czech first, who felt it his duty to tell all of us (through the hard working interpreter) all about how he was selected and trained, how he felt, what it was like, what apparatus was used. As the sessions progressed, we learned a lot more than we wanted to know, and much of what we might have wanted to learn was lost through the interpretation and the gap between interpretations, like foreign language commercials interrupting TV. A 16mm uncut film taken aboard Salyut 6 was shown — fascinating stuff — and two whole reels of 35mm. The 35mm projector was cantakerous, first because the projectionist had apparently gone to sleep in the back, then because its lamp was so dim that the picture could hardly be seen. Alexei Leonov, Hero of the Soviet Union, Cosmonaut Exraordinary, the first human to walk out into space, strode down from the dais with a retinue of Petrov's subordinates. There was much incomprehensible talk. The projector was moved closer to the screen. A longer extension cord was sent for. Interminable questions and answers were thrown into the hiatus. Finally the last half of the 35mm was run through and those who had stuck it out staggered from the conference hall for a drink and supper.

From the films Salyut 6 appeared much smaller and confined than Skylab, and the equipment less complex and sophisticated. There was considerable discussion of the effects of weightlessness, the cosmonauts saying it required intensive physical training to adapt to it. Academician Petrov summarized that science cannot say today how long a human may stay in space.

In answer to a question regarding how to avoid space sickness, one of the cosmonauts said that most important were the selection and training of the cosmonaut, and exercise. He said that special medicine was carried in Salyut, but never used, while a pressure suit was used at times to redistribute the blood by putting pressure on the lower limbs and so increasing the flow to the upper limbs, chest and head. The suit was shown in use in the films both on the ground and in Salyut 6. The ingredients of the special medicine, however, were not disclosed; indeed singularly few technical or scientific details were disclosed during the session.

Tuesday there were 10 more sessions and 90 more papers.

Four of the 41 student registrants were Stan Kent from Stanford University, whose tiny blonde bride was the darling of the Congress, Andy Bellenkes from the University of Delaware, Jess Murph from Auburn University, Alabama, and Rex Ridenoure from Iowa State. They had won the opportunity to present their papers at the Congress in a nationwide contest sponsored by the American Institute for Aeronautics and Astronautics. Kent's paper #78-ST-09 on "The Space Shuttle External Tank as a Re-entry Module" won first prize and the Hermann Oberth Gold Medal for the best undergraduate paper at the Congress' closing banquet Friday night. Bellenkes' paper, #78-ST17 on "Space Medicine—A Prognosis for Future Research", won second place in the graduate category. Rex Ridenoure's excellent paper, #78-ST-07, "The Collection of Lunar Mass Driver Payloads in Earth-Moon Space," won second place in the undergraduate category.

Late in the week Kent presented Gordon Woodcock's challenging paper #78-231 on "Low-Cost Transportation of the Future" so competently that Woodcock will do well to look to his laurels. (It was one of the students, incidentally, who observed that some people were more interested in useful pieces than in peaceful uses of outer space.)

Tuesday morning Dr. Dono Indarto, of the Department of Communication, Djarkarta, Indonesia, presented a paper (78-A-65) at the second session of the 11th International Space Rescue and Safety Symposium. A paper presented Monday at the first Communication Satellite session (78-239, H. Soetaya et al) had described the Indonesian Palapa System. Indonesia has 13,000 islands, 7,000 of which are uninhabited. Communication between them via satellite would be a boon, but western science must be introduced with care in order not to disturb social and political stability. For example, local custom in many villages decrees that a message is urgent only if the messenger carries a chicken feather in his hand. The idea of giving high priority to rescue messages delivered in technical language through a loudspeaker or headset is hard to get across.

> *Fear. . .is the principal cause of failure of global peace. . .*

Tuesday evening at 5:30 there was an excellent French presentation with slides and film on the current status of Ariane, the launch vehicle being developed by EAS, and an Italian report on the Spacelab program. This was followed at 8 P.M. by superb folk dancing and singing by the Lindjo troupe in a barrel-vaulted medieval hall in Dubrovnik's Old Town.

Wednesday morning the first session of the 21st International Space Law Colloquium was held (16th session of the Congress). It was chaired by Mrs. I.H. Diederiks-Verschoor of the Netherlands. L-5's distinguished Board Member, the Honorable Edward R. Finch, Jr., presented paper #78-SL-03 on the subject of "Outer Space Global Interdependence and the Geostationary Orbit".

Referring to the theme of the Congress—"Astronautics for Peace and Human Progress"—he said that, because of the precedents set by Gemini and Soyuz-Apollo and the 1967 Treaty on the Peaceful Uses of Outer Space, until 2100AD no more regulation of geostationary orbit in outer space should be needed.

Fear, he explained, is the principal cause of failure of global peace. The 1967 Treaty banned nuclear weapons testing and military manoeveurs in outer space and its provisions have been followed. Verification by viewing the Earth from outer space is a way for a nation to protect its sovereignty and national security and lessen fear of attack. The UN Committee on the Peaceful uses of Outer Space (COPUOS) helps keep the peace by its sponsorship of the four major space treaties and by encouraging remote sensing.

The United States and the USSR have agreed, he revealed, to open talks on "killer" satellites.

The fear that GSO is becoming overcrowded is unfounded, Finch explained. To limit the geostationary orbit to 180 satellites (one satellite every 2 degrees) as has been suggested, is unneccessary. With 10-20 kilometer spacing between satellites, well over 1800 satellites could be placed in GSO without interfering with one another. Until after the year 2100 there need be no scientific or legal fears of overcrowding, even without considering antenna farms.

The claims of equatorial countries to the outer space above them on geostationary orbit, Dr. Finch asserted, are not valid. Outer space (beyond a not yet determined distance from the surface of the Earth, but probably at 100-110 kilometers altitude) is part of the "freedom of outer space" for the benefit of all.

In subsequent papers and in discussion, Ed Finch's thoughts were supported and amplified. Dr. K. Wieworouska of Poland held that space in Geostationary orbit was not subject to national sovereignty, and that, although the definition of outer space is not clear at present and may be set somewhere between 70 and 700 kilometers from the Earth's surface, most people agree that GSO is outer space.

Dr. Haanappel of Canada noted that Colombia, which is claiming the portion of GSO which lies above it, is not a signatory of the Outer Space Treaty; he held that GSO is a limited resource which must be regulated, not de facto monopolized. He felt that satellites in GSO should be no closer than 2 degrees apart, which allows room for only 180 satellites.

Dr. Rudolf Perek (Czechoslovakia), Chief of the Outer Space Affairs Division of the UN, said that the principle of "first come first served" was still in effect at the ITU (International Telecommunications Union) and that some people feared this principle would be abused. But spots on geostationary orbit, Dr. Perek believed, should be used the way sidewalks are used, shared with others, and not individually owned.

President Diederiks-Verschoor (Netherlands) presented a paper (78-SL-15) on the "Legal Regime of International Space Flight," in which she posed the problem of the legal rights and obligations of the commander, crew, and passengers of spacecraft. Strict regulations, such as those guiding commanders of aircraft, do not as yet exist for spacecraft, but should be considered now in preparation for the day when they will be needed.

More than 40 papers on space law were presented. In Finch's opinion, space law at the present time is the pacesetter for the evolution of international law and is progressing much more rapidly than the law of the sea.

Later in the week one of the benefits of the Congress, the ability to once in a while bring corridor discussion to session debate, appeared in a question period in the Thursday afternoon session of the Space Law Colloquim. Dr. Yuri M. Kolossov, Soviet Representative on the UN Committee on the Peaceful Uses of Outer Space, said that peace in outer space is inseparable from peace on the surface of the Earth, and that the reasons that we have avoided World War III are sociological and political. Astronautics may help provide peace on Earth, but only political decisions can provide for peace and human progress. If there is no peace, Dr. Kolossov said, there can be no human progress.

In the vernacular of international space law, "stabilizing" apparently means peaceful, and "destabilizing"means hostile. Was broadcasting from orbit to other countries stabilizing? No, said Dr. Kolossov. Was first come first served use of geostationary orbit stabilizing? No, he said; GSO should be used under the ITU in cooperation with other nations. Was obtaining solar energy from space stabilizing? Yes, he said, it was, but like all goods obtained from space it should be shared with others. Satellite solar power stations, Dr. Kolossov said, could clearly contribute to peaceful human progress. Now whether he said this because the Soviets are about to embark on an SPS program themselves, or because they hope that the United States will start building power satellites without adequate research, or because he really believed power satellites would be benign, is a mystery shrouded in an enigma. But at least he said it, and in a public session.

Finch asked why direct broadcasting from a satellite is destabilizing. Dr. Kolossov replied that direct broadcasting was not acceptable to a receiving state unless the receiving state's prior consent had been received. He further said that remote sensing by satellite was destabilizing if the information obtained was made available to other than the state doing the sensing or the state being sensed. At the next day's Colloquium there was lively discussion on the benefits of freedom of information versus prior consent.

Thursday afternoon at 5:30 Dr. Robert A. Frosch, Administrator of NASA, appeared on schedule. His talk was meticulously careful and, to this correspondent, uninspiring. Perhaps this is unfair. It may just have been his manner of delivery.

Dr. Frosch said President Carter's policy was that the United States will continue its leadership in space, that the space program is in a time of transition, as aviation was 20 years after the Wright brothers' first flight, and that there is now a shift from a single goal (going to the Moon) to multiple objectives involving extending technology, developing applications in such things as communications and remote sensing, and in the scientific field exploring the solar system, supporting, on the one hand, cosmic astronomy, and the environmental relationship between the Earth and the Sun.

Satellite solar power stations...could clearly contribute to peaceful human progress.

Satellite Power Stations are not in NASA's operational program, and permanent space stations are not either. According to Frosch, NASA is taking the evolutionary view rather than jumping in before all the details are understood.

Dr. Frosch said it is difficult to characterize NASA's present posture in a single sentence or simple objective because we are maturing in space matters. As opportunities for the use of space come along we will be able to grow with them, continuing the growth of the peaceful uses of space for human purposes.

Dr. Frosch's talk was followed by an excellent slide show and film narrated by Lee Scherer, Director of the Kennedy Space Center, describing the development and present status of the Shuttle Program. The main engine problem is aparently under control, and the first flight to orbit should be next September if the present "success oriented scenario" continues.

Friday morning Session 34 was on "Space-Based Power Systems for Earth." Clark Covington of NASA's Johnson Space Center in Houston, delivering paper #78-185, led off with a magnificent report on "Satellite Solar Power Stations." Covington is owlish and balding, stocky, and not particularly impressive to look at, but spoke with conviction, vigor, and enthusiasm. It was refreshing and worth the trip to Dubrovnik to hear him. NASA, Covington said, is responsible for system definition. The Department of Energy is responsible for evaluation, environmental health and safety. In September, 1980, the decision will be made to either drop the idea of solar power satellites or go ahead. Covington expects the technology to construct SPSs from Earth materials to be available by 1990, and the first commercial SPS could be delivering 10 gigawatts to Earth surface grids by the year 2000.

He said NASA had looked at Brayton, Rankin, and other power conversion systems as well as silicon and gallium arsenide solar cells, and believed photovoltaic the best bet at present. The five to ten gigawatt size is best for physical reasons, such as the power density in the ionosphere and the need for cooling the one kilometer diameter transmitting antenna. A silicon cell SPS would be 5 by 10 kilometers on each side, feeding to a 10 to 13 kilometer diameter rectenna on the ground. Power density would be 23 mW per cm^2 at the center of the rectenna, less than 1 mW per cm^2 at the edges.

Research, development and testing costs will probably be $39—40 billion spread over 15 years (in 1978 dollars). The first power satellite will probably cost $32 to $43 billion, and succeeding satellites $12—17 billion each. Transportation will be approximately 40% of the cost.

David Akin (a colleague of L-5 reporter and guest editor Eric Drexler) presented paper #78-186 in collaboration with Professor Rene H. Miller at MIT. It was on the "Logistic Costs of Satellite Solar Power". Carefully researched and brilliantly presented, it took the line approach to costs (rather than the NASA point approach), but arrived at similar conclusions, that solar power satellites are economically feasible. If more than 5 satellites were built, he said, it would be cheaper to build them from lunar materials.

R. Fleisig of Grumman Aerospace, in paper #78-188, presented a scenario for building a test SPS in space from Earth materials and showed slides of a pilot model of an automated beam builder which has successfully built 100 meter beams from rolls of aluminum.

Marcel Toussaint, Director of Eurospace, delivered paper #78-190 on European energy needs, saying satellite solar power stations would be welcome, particularly in the $10 billion cost range.

Leafing through the 84 page Programme during the after the Congress was an exercise in frustration. So much to hear, and so much to miss! There was no paper on constructing our Society's conference hall at L-5, (the one where we will assemble in a decade or two), but there were many papers on building large structures in space and on the various aspects of living there. There was, for example, Pres Layton's (USA) excellent "Progress Report on the IAF Working Group on Space Energy and Power (#78-37) in which he showed many of the slides of power satellites and space colonies which are in the L-5 collection. Several Soviet papers, such as #78-A-56 on "Man's Adaptation to the Operator's Work Under Stressful Conditions of Space Flight"; #78-47, "Preliminary Medical Results of Salyut 6 Manned Flights"; and #78-55, "Study of the Cabin Environment: Composition of Toxic Gas Containment as a Function of Specific Volume" applied to living in space. Three sessions discussed Bionautics (#28, #39 and #45). A session (#37) discussed materials and structures and a joint paper (#78-SL-38) by Patricia M. Sterns and L.I. Turner from Arizona dealt with the "Art of Living in Space". There was considerable reference to space manufacturing, particularly in Session 34 on "Space-Based Power Systems for Earth," but little tying the need for personnel to build and repair things in space to where and how the personnel might live. Perhaps some L-5 member will present a paper on this subject next year! This correspondent sensed that, after Skylab and Salyut, maybe most Congress participants felt that living in space, when it becomes necessary, will not be a serious problem.

Friday night, at the closing banquet in the Hotel Libertas, Christopher C. Kraft, Jr., Director of the Johnson Space Center at Houston, received (in absentia) the 1978 Daniel and Florence Guggenheim International Astronautics Award of the International Academy of Astronautics for his outstanding contribution to space research and exploration during the past five years.

The 1978 Allan D. Emil Memorial Award for international cooperation in space was presented to Glynn S. Lunney of NASA and Konstantin Davydovich Bushuyev of the Institute of Space Research in Moscow.

The International Institute of Space Law presented awards to Dr. V.S. Vereshchetin (USSR) and Dr. N.M. Matte (Canada) for outstanding and distinguished contributions to the evolution of the internation law of outer space and in recognition of their efforts for world peace through international law and understanding.

On Saturday morning, the last day of the Congress, Stan Kent, winner of the first prize for a student paper, delivered Gordon Woodcock's paper on "Low Cost Space Transportation of the Future". He said costs of space travel should come down to compare with travel by jet today. A market is needed, he said, for a reusable vehicle. SPS provides this market, and a reuseable heavy lift launch vehicle (HLLV) should bring costs down to $34 per kilogram from the Earth's surface to low Earth orbit. This should come down further, to $15 per kilogram as new technology develops.

G.C. Hudson of Foundation Inc., St. Paul, Minnesota, presented paper #78-233 on Advanced Propulsion Systems and Solar System Spaceships. Up to this point few papers assuming substantial advances in science and technology had been presented. Hudson's paper described some possibilities that will arise if some of the theories now being researched could be reduced to practical hardware. Progressing from Project Orion, a system for propelling very large space ships with small nuclear fission bombs, through adaptations of the fusion process to the manufacture and use of antimatter, he showed slides and diagrams of possible space ships of the future. They would be about the size of a DC-9, and capable of carrying passengers or cargo for $5 a pound with a 3½ to 4 hour transit time to the lunar surface.

The Soviets have put up four times as many satellites as we have over the past two years, and their Salyut flies mockingly above us.

Closing speeches were delivered at noon Saturday in the conference hall. Monsieur Barrere courteously thanked our Yugoslav hosts, and a bone-weary, but still game Professor Andjelic accepted on behalf of an also grateful Dubrovnik, and said a message from the Congress would be sent to the cosmonauts who, having spent more than 100 days in space, were at the time still orbiting above us in Salyut 6.

Looking forward to seeing all registrants in Munich next September 17-22, Monsieur Barrere announced the election of Dr. Roy Gibson as the new President of the IAF and closed the conference.

To your neophyte correspondent it was a sometimes confusing, often enlightening, always challenging experience, not yet digested, but nonetheless vastly satisfying. The second echelon of American talent in space was well represented at the Congress and distinguished itself with a series of brilliant performances, but there was concern that the top American leadership, the Administration and some members of Congress in Washington, were less than enthusiastic, and that perhaps the country's top creative talent was dropping out of NASA and DOE.

There is reason for concern. Partisans like Proxmire, Abourezk and Ottinger remind me of those who criticized "Crazy Red" Jefferson's purchase of the Louisiana Territory, Seward's "folly" in buying Alaska, and Theodore Roosevelt's "outrageous" expenditures on the Panama Canal. Proxmire's "golden fleece" awards, by hobbling the space program, are fleecing us of our birthright!

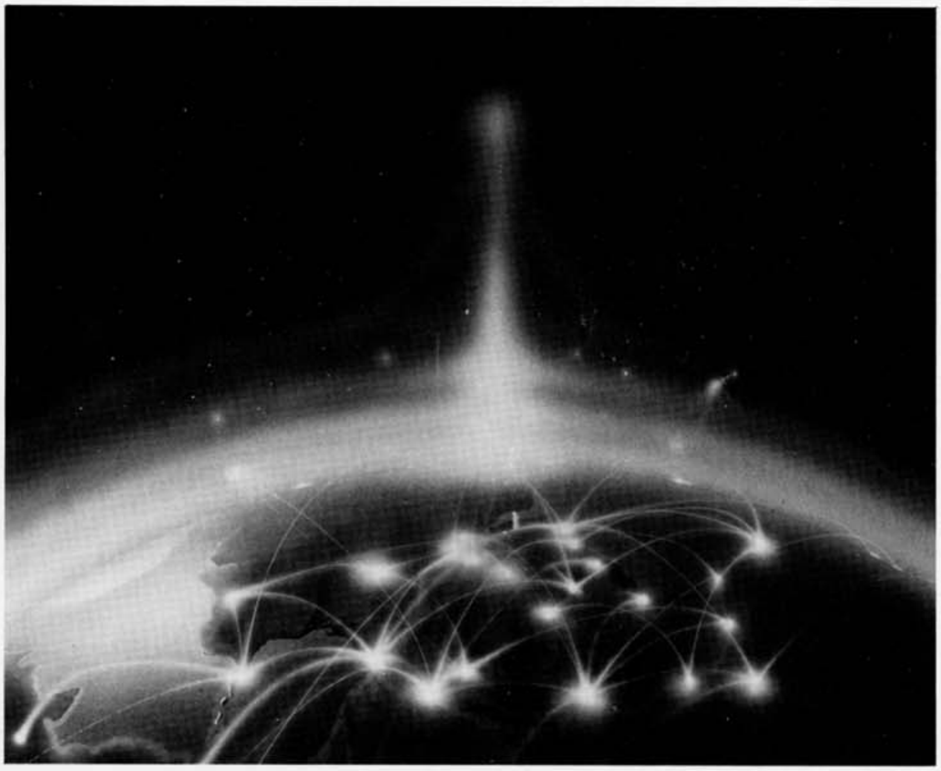
Fortunately, however, as history has repeatedly demonstrated, a relatively few dedicated and determined souls can still change the world. There were many of them at the XXIXth Congress of the IAF. It is unrealistic to ask that everyone, or even that every U.S. citizen join in opening the new solar system frontier, but it is reasonable to ask our government to help build highways to orbit, to assist space homesteading and to aid space manufacturing with the use of extraterrestrial resourses of the solar system. Except for the infinite amount of space available and the lack of hostile natives, the new frontier fundamentally resembles those that have been opened before.

Russia is trying to assume the leadership we seem to be relinguishing. The Soviets have put up four times as many satellites as we have over the past two years, and their Salyut flies mockingly above us. Yet they often fumble the ball. As overheard in a side-bar conversation at the Congress, it is very difficult to develop high creative technology in a dictatorshop. (God knows, it's hard enough in a bureaucratic democracy!).

In the opinion of this correspondent, in the many different faces at the Congress there were eyes looking to America, as eyes the world over have looked to us for 200 years, as the brightest hope for humankind.

Failure of leadership in the American space effort could be a calamity to our species, a catastrophe for our country, and a tragedy beyond all speaking for those who believe that dreams can come true.

Theatre for the Future



The Theatre for the Future is a one-hour and fifteen minute computerized multi-media presentation. Barbara Marx Hubbard serves as "conductor" of a tour that covers the fifteen billion year drama of our evolutionary history through the present period of radical change. It culminates with "previews of coming attractions"—positive images of the future based on our growing capacities in all fields . . . what it might be like if everything worked!

It is one of the first post-modern visions of the future based on the achievements of Western Civilization—in religion, science, industry, technology — which affirm our faith in humanity.

"Previews" traces a logical rationale for hope based on the pattern of crisis, apparent limits, innovation and transformation which has operated from the creation of the material universe, through the formation of our solar system and Earth, single celled life, plants and animals, Homo sapiens to the present age, pointing to the year 1945 as the beginning of the new transformation. It provides a new, overarching perspective to understand the long-range directions for human growth and development.

Barbara Hubbard quotes Teilhard de Chardin: "the philosophy which will prevail is the one which calls us to action." She believes that the future is a contingency, not an inevitability. "In our society we have learned to organize against injustice and problems. Now we must learn to organize for possibilities. The Theatre for the Future is a stage upon which to envision action for the future."

By condensing our fifteen billion year past into a rapid continuum of transformation, a "photo-genesis"—she identifies the patterns in the process of change and uses those patterns as indicators to enhance our roles as conscious and successful designers of the future.

In its performances to date "Previews" has played to a cross section of audiences and has demonstrated its appeal to a wide variety of people, from space scientists to government officials to humanistic psychologists.

Quotes about The Theatre for the Future:

"A flight of fancy? No. A consummate perception of reality mounted in a fanciful frame. A penetrating work that examines the existence of the universe minutely and offers humankind a valid reason for being and continuing to be. Tomorrow is provocatively promising for all humanity in Barbara Marx Hubbard's concept." (Margaret Adams, Public Affairs Editor, Good Housekeeping Magazine)

"The Theatre for the Future is very exciting and important. I feel very glowing about it." (Liz Campbell, Executive Officer, Assoc. of Humanistic Psychology)

"The presentation gave a message of hope. In addition it represented a unified and well integrated approach to the future and has a message of critical importance for all people." (Dr. Frank Kapper, Science Advisor to the Joint Chiefs of Staff)

"I cannot recall ever having remained so still for two hours for anyone! The audiovisuals were beautiful and interestingly done, but diminished substantially in impact compared with the substance of your message." (George Robinson, Washington attorney)

"The Theatre for the Future is a compelling and creative answer to the seemingly omnipresent philosophers of doom in our society whose constricted imaginative powers enable them to see only famine, pestilence, and economic contraction on the horizon." (Congressman David Stockman, D-Michigan)

The production is designed to accompany Ms. Hubbard, providing her the freedom to address the specific interests of her audience. For example, she has recently completed her sixth keynote presentation to the U.S. Civil Service Commission's series of Executive Seminars, for government policy makers, applying the evolutionary perspective to long-range decision-making. The director of the conferences has asserted that he doesn't want to start a seminar without her—because she opens participants' minds to possibilities which transform their interpretation of the crisis they face.

"Previews" combines the familiar and the new to keep the audience engaged. Preproduced sections such as "the Divine and Secular Dialogue" on the creation of the universe, and the "Dawn of Human Consciousness" add theatrical excitement to the Theatre.

"The Theatre for the Future is more than theatre and more than a single idea," said Marvin Goldman, Washington, D.C. businessman and president of the National Association of Theatre Owners. "It is an experience which has changed my whole outlook on the present and the future."

Over the next year the Theatre will be booked for one-week stands in Washington D.C., Minneapolis, San Francisco, Houston, Atlanta, Los Angeles and New York. It will be available for organizations and special presentations with dates set for the International Convention of the Girl Scouts in Denver in October and the Association of Humanistic Psychology's national gathering on the theme: "Between Dreams—Toward a New Mythos" in Toronto in August.

For more information, write
to Theatre for the Future,
2325 Porter St. NW,
Washington, D.C. 20008

Golden Sheep Drop honors cheap shots

by Donald Morris

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The Houston Post

This column normally appears only in a single newspaper and cannot, of course, hope to reach the audience available to a representative or a senator who issues a release to national media representatives. Sen. William Proxmire — Wisconsin's pride — can consequently count on an enormous audience when he makes his monthly Golden Fleece award (established in March of 1975) for the "most outrageous and ridiculous" waste of taxpayer dollars.

This column herewith establishes a Golden Sheep Drop Award, which will be conferred from time to time on the member of the legislative branch who has taken the cheapest shot at the easiest target for the purpose of getting his name in the media. The first award, a special triple-life-size, handsomely mounted specimen, goes to the foremost master of the cheap shot, William Proxmire himself.

There is indeed a horrendous waste of taxpayer's dollars, which can be traced back all the way to the expense accounts Gen. George Washington submitted to the Continental Congress. The proportion of tax dollars wasted has been fairly constant over the decades, rising as the population has grown, simply because systems coping with larger numbers become more complicated, and thus more subject to abuse. And the system that can't be abused has yet to be devised.

A percentage of waste is inherent in any large system, and while waste is outrageous — and can easily be made to look ridiculous — it is rarely deliberate. Most waste cannot be foreseen and occurs as the result of an honest effort to get something done that needs doing.

Governmental waste has a peculiar cycle. It starts with a popular demand for government to assume a function — to do something — which is then enacted and funded by the legislative branch. It is then turned over to a bureaucratic entity — newly established or already existing — for implementation.

This organ — a department, bureau, agency or whatever — is a creature of the legislative branch,' which has established it. Legislators have determined how many people, of what grade, can be hired, how much money is to be spent and what is to be done. The people who try to do it — our civil service — come from the same backgrounds all of us do; they are reasonably intelligent people trying to do what is often a difficult and always a thankless job as best they can. The legislative branch, which is responsible for all of it, spends an inordinate amount of its time picking at this work, jeering at the civil service, accusing it of waste, corruption, dishonesty and general malfeasance, acquiring in the process a reputation (from an appallingly uncritical media) as vigilant guardians of the public purse, knowing all the while that the targets are not in a position to make any answer.

Proxmire's latest Golden Fleece went to NASA — for mounting a two-year, $2 million program to communicate with other planets. (Proxmire is obviously referring to planets in other star systems.)

The same day as Proxmire's award, this newspaper carried an editorial pointing out that our country has been in a slow decline in scientific research for some time, because federal investment in research and development has dropped 77 percent since 1965. It is the cheap-shot artists in the legislative branch — led by the Proxmires — who can claim the lion's share of the credit for that. It is they who choke the funds, and in between ridicule the existing projects in basic research, playing for the indignant outrage of ignorant and anti-intellectual constituencies.

In the present case, the world's scientific community is overwhelmingly certain that intelligent life exists elsewhere in this galaxy. Scientific (as opposed to popular) belief is also overwhelmingly certain that no extraterrestrial beings have yet landed on our planet, and equally certain that mankind will not be able to travel beyond the limits of this solar system within the framework of our current technology (i.e., for a number of centuries to come). The chances of extraterrestrial beings reaching — or at least communicating — with us are thus considerably better than the chances of our being the first.

A program to cope with interstellar communications is thus reasonable and sensible and on the current modest scale no waste at all — certainly not an "outrageous and ridiculous" waste. Imagine the outcry (and guess who would lead it), if the millenium were to arrive with an indubitable encounter and there we were, with our bare faces hanging out and not a vestige of a framework for responding.

How long will it take this nation to realize that the real misgovernment, the real waste, the real clowning, is not lodged in either the civil service or the executive branch?

When in Washington D.C. explore the planets

The National Air and Space Museum's new Exploring the Planets Gallery opened November 7. The Gallery takes visitors on a tour of the solar system via space missions and observations from Earth.

Photography, film footage and special displays illustrate how human beings and their machines have explored the planets and what has been learned.

Among the special exhibits is a "Flight Over Mars." Parts of the Martian landscape have been sculpted onto rotating cylinders which, when viewed through special windows, allow visitors to feel that they really are flying over Mars.

Visitors also may make a "Descent to Venus" in a simulated cockpit of an interplanetary spaceship, circa 2150. On this sightseeing tour, a computer voice gives landing instructions to the pilot as the Venutian landscape grows nearer on the "capsule's" video screens.

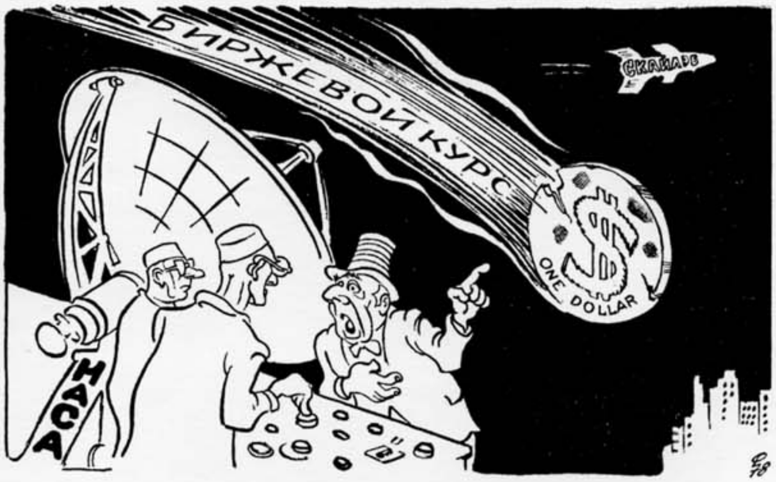
The Gallery includes an animated film on the planets for children, six computer terminals where visitors can take a quiz on the planets and videotaped weather reports from the other planets—by one of Earth's meteorologists, Gordon Barnes. There also is an area devoted to the emerging field of comparative planetology, comparing such factors as atmosphere and volcanism on different planets.

All the planets are presented in the Gallery and information panels, models, photographs and special exhibits give their vital statistics summarizing what is known or deduced today. As new data is gathered, the exhibits will be changed.

The final section in the Gallery is entitled "Unanswered Questions." Superimposed on illunimated photographs are a set of questions that have stumped scientists for centuries, such as "is Pluto an escaped moon of Neptune?" or "what is Jupiter's red spot?" In several years, hopefully, the name of this particular section may have to be changed to "Answered Questions."

The National Air and Space Museum is open seven days a week from 10 a.m. to 5:30 p.m. Admission is free.

Ученым НАСА удалось перевести терявший высоту «Скайлэб» на более высокую орбиту. ✦ Курс доллара продолжает падать на всех биржах мира.



— Поднять курс доллара? Здесь наука бессильна, сэр!

Рис. В. Фомичева.

Caption at top: "NASA Scientists were able to fix the falling height of "Skylab" . . . the course of the dollar continues to fall on all world markets." The rocket is labeled "Skylab", the meteor trail is labeled "market course". The remark at the bottom says "Correct the course of the dollar? Here science is helpless, sir!" (Reprinted from **Izvestia**, August 1978, courtesy James Oberg.)

NASA Squelches US/USSR Cooperation Talk

News flash — December 18 NASA announced that the US "save Skylab" mission has been cancelled due to excessive solar storms, difficulties with Skylab control systems and shuttle development delays which have pushed back the first date for a rescue to April 1980. Some NASA insiders claim, however, that the Soviets could reboost Skylab if we were to initiate a joint rescue mission soon. The following is the text of the NASA Memorandum, dated September, 1978, which has muzzled proponents of a Soviet aided Skylab rescue.

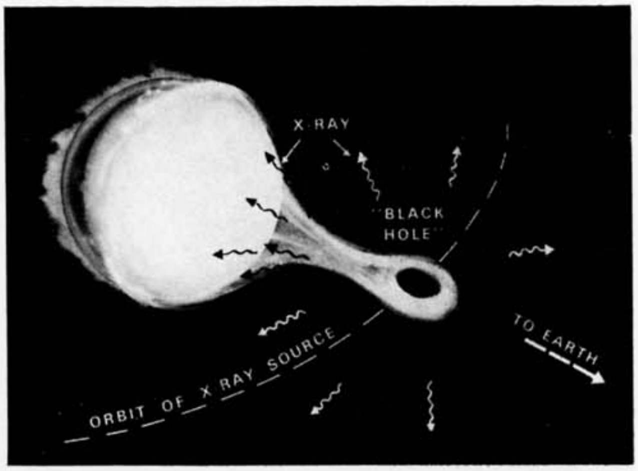
(Text of a NASA memorandum dated September 7, 1978)

There have been recent press inquiries concerning future US/Soviet space cooperation. In view of the sensitivities of this subject, any response you make to such inquiries should be along the following lines:

"We have had a successful program of space cooperation with the Soviet Union for several years. This program has included the jointly-manned Apollo-Soyuz Test Project and a wide variety of unmanned activities of the two sides. A 1977 agreement between NASA and the Soviet Academy of Sciences calls for a study of the objectives, feasibility and means of carrying out a joint experimental program involving the US Shuttle and the Soviet Salyut. Preliminary discussions on this subject were held in Moscow last year. No further discussions have been scheduled pending a comprehensive US interagency review of the entire subject. We cannot predict when this review will be completed or what the outcome will be."

Any inquiries which might take you beyond this statement should be discussed and cleared with NASA Headquarters Public Affairs and International Affairs.

One other different kind of comment—in general, we should not comment on successes or failures of foreign space activities without NASA top management approval.



Space Phenomenon under Study—The structure of a black hole as envisioned by scientists shows the gas clouds of a visible star swirling around and into the X-ray source or black hole. It sucks in vast quantities of matter as it orbits the star.

Copernicus Finds Second Black Hole

After a two-month search, the Goddard Space Flight Center's Copernicus satellite has located what may be a second invisible "black hole" in the universe in the constellation Scorpio. The satellite's X-ray experiment found the black hole, believed to be a super-dense collapsed star with such strong gravity that not even light can escape it.

"This is the second black hole found in our galaxy," said co-investigator for the project Glen Pollard. "It is much more active and convincing than the first, Cygnus X-1."

The invisible black hole is orbiting Scorpio V-861, a super giant star which can be seen with the naked eye from Earth. It is gradually siphoning away the larger star's atmosphere.

The massive amounts of X-rays released from matter as it is transported from the giant star led the scientists to what another co-investigator, Ronald Polidan, calls "the best black hole yet."

Most importantly, the scientists say, the discovery has given astronomers their first opportunity to study a black hole as it passes behind its companion star. The new data will give astronomers a chance to test some of their black hole theories. Pollard hopes the new information will define the shape of the cloud of stellar material being sucked into the black hole, thus revealing some of the dynamics of black hole systems. It also may provide a measure of the quantity of material being removed at speeds up to 3.2 million kilometers per hour.

Studying black holes also will extend astronomers' knowledge of physics into realms of laws not observable on Earth—the Physics of Relativity.

Astronaut Candidates Learn Water Survival Techniques

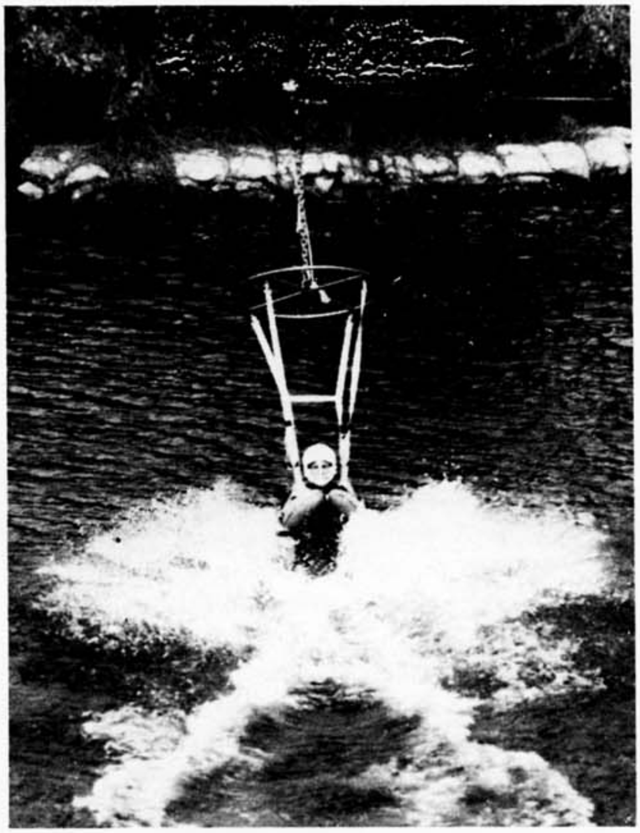
Sixteen astronaut candidates from the Johnson Space Center spent July 31 to Aug. 4 in training at the Homestead Air Force Water Survival School in Florida. Most of the 35 astronaut candidates had experienced the water survival training before entering the NASA program. Included among the 16 are the 6 female astronaut candidates now in training.

Each day's activities during the course included classroom lectures on water survival techniques plus actual training in the water environment. Briefings on procedures preceded each activity.

The training also covered jumping from a tower while wearing a tethered parachute harness, and sliding down a wire to a landing in the water. The candidates also were towed through the water in a parachute harness, a simulation of being dragged across the surface by parachute and having to accomplish release.

Other exercises required astronaut candidates to be towed aloft under a parasail canopy, land in the water and be picked up by boat. On the final plunge into the water suspended from the parasail, astronaut candidates came down with full survival gear. A helicopter picked them up from a life raft.

The Air Force Water Survival School is operated by the 3613th Combat Crew training squadron with headquarters at Fairchild Air Force Base, Wash.



Splashdown!—An astronaut candidate hits the water after sliding down the wire from a 13-meter tower. Afterward, the student must release from the parachute harness, swim under a parachute canopy and climb into a life raft.

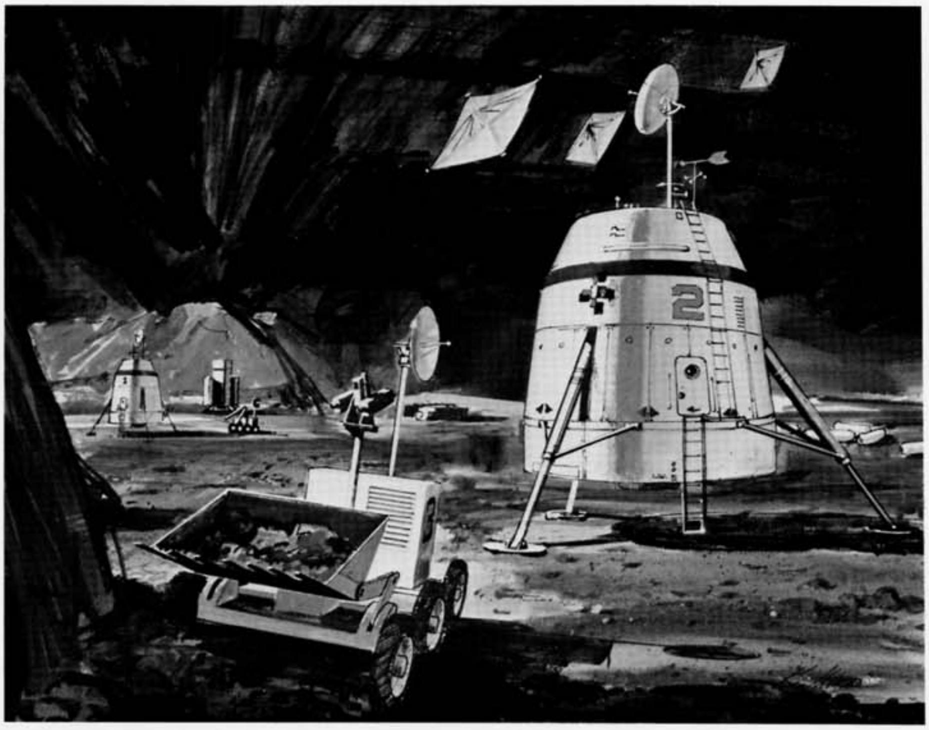
Determined Effort—Candidate Sally K. Ride swims toward the dock in a Florida canal at the water survival training site after the "drop and drag" phase of training.

No Bellhops Needed—Astronaut candidate Judith Resnik carries training gear to a large freshwater tank at Turkey Point, Fla. to clean saltwater from equipment, a program requirement.

Mining the Moon

by William N. Agosto

Most of the studies I've seen on processing lunar materials for industrial use focus on smelting metal out of oxides and silicates in lunar soil. But there is a much more accessible metal resource on the Moon. It is metallic nickel-iron powder which makes up about a half of a percent by weight of the finely divided lunar soil. About 10% of Moon soil metal is in the form of free standing metal particles without silicate or other non-metallic attachments. That means that approximately 2 billion metric tons of pure nickel-iron powder are available in the top 10cm of soil over the entire lunar surface. And there's more below. The idea that high energy chemical engineering has to be used to obtain structual metal from the Moon is probably Earth metallurgical chauvinism. There is, after all, no free iron to speak of in the Earth's crust. But on the Moon, you can scoop it up with a magnet.



An artist's concept of a lunar mining base.

Nickel-iron is the most magnetic fraction of lunar soil. Several magnetic passes at the proper field strength may extract soil metal to 98% purity (1). And there are electrostatic techniques for separating soil metal as well. One method called tribo-electrification was reported by Ion Inculet of the University of Western Ontario at the Lunar Planetary Conference in Houston last spring (2). Tribo-electrification separates particles according to size, dielectric constant and conductivity. It has been used to separate hematite iron ore from slag and carbon from fly ash in industrial exhausts. It can be automated, uses little power, and works best at low humidity. In the dry lunar environment, it could be a very effective soil separating process, not just for iron, but other particulate minerals as well.

The metal powder thus obtained can be fabricated into machine parts and tools by powder metallurgical techniques which mold the finished product directly without machining. As a matter of fact, in the dry lunar environment it might be possible to substantially reduce powder sintering temperatures and pressures of about 800°C and 10,000 psi used on Earth (3). Alternatively, the metal powder could be melted in solar furnaces, residual slag skimmed or vaporized, and the metal parts evaporated directly onto core molds using the techniques proposed by Drexler and Henson (4).

The high nickel content of the powder alloy (about 10%) will toughen the finished product and probably more than compensate for residual non-metallic inclusions. There is very little chromium (less than 0.1%) and correspondingly more phosphorus (about 5%) in lunar metal. But anticorrosive components like the chromium in Earth stainless steel may not be necessary in space metal under the low oxidizing conditions of most cislunar applications.

Extremes of processing temperature can be readily maintained on the Moon, for example, in underground cyrogenic (super cold) chambers. Molten metal could be poured directly into lunar cyrogenic pits to achieve the precipitous cooling rates necessary to make metallic glass (one million degrees C temperature drop per second). Metallic glass has many desirable properties. It is far more corrosion resistant than standard crystalline metal of the same formulation. It has three times the tensile strength of steel and withstands 50% more shear stress. It also has very versatile electromagnetic properties that make it suitable for magnetic memory and superconducting applications (5). Metallic glass could be made on the Moon and might become the ideal source of superconducting magnets for mass driver operations in space.

The more you look at the Moon, the better it looks from the industrial point of view. There are abundant stores of aluminum and titanium ores in an already finely subdivided state. There are implanted volatiles and carbon from the solar wind in the soil and a host of glass making components. But Moon metal is probably the most accessible space structural resource of them all.

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Carter Sets Space Policy

by Leonard David

Carter space program "will reflect a balanced strategy of applications, science and technology development."

President Jimmy Carter has released the long-awaited official space policy for the Nation, designed to "set the direction of U.S. efforts in space over the next decade." The ink had hardly dried on the document before space critics complained of its inadequacies, and two senators introduced separate space policy bills.

The White House U.S. Civil Space Policy comes as a result of a four-month interagency review requested by the President back in June of this year. Many Washington, D.C. space watchers, both official and unofficial, have given the Presidential policy a C-, pointing to its lack of goals and deficiency in establishing a base for America's space future.

The Carter policy centers on three principles, with prime interest given to a space program which "will reflect a balanced strategy of applications, science and technology development," according to a White House press statement. The key elements of this program emphasize Earth applications, such as climate, weather, pollution, and resource monitoring satellites and a space science and exploration program that is vigorous, yet provides for a "short term flexibility to impose fiscal constraints when conditions warrant." Also outlined are supportive statements of space cooperation with other nations, as well as the need to take advantage of the Space Shuttle's flexibility to reduce the cost of operating in space.

A second specific aspect of the policy notes that "more and more, space is becoming a place to work—an extension of our environment. In the future, activities will be pursued in space when it appears that national objectives can most efficiently be met through space activities." The policy's third theme is bound to put a damper on those ready to dip into zero-gravity swimming inside a space colony anytime soon. States the policy, "It is neither feasible nor necessary at this time to commit the U.S. to a high-challenge space engineering initiative comparable to Apollo. As the resources and manpower requirements for Shuttle development phase down, we will have the flexibility to give greater attention to new space applications and exploration, continue programs at present levels or contract them. To meet the objectives specified above, an adequate Federal budget commitment will be made."

As for power-generating satellites, the Carter policy is equally as direct. "It is too early to make a commitment to the development of a satellite solar power station or space manufacturing facility," relates the policy, "due to the uncertainty of the technology and economic cost-benefits and environmental concerns." But, as if to give space colonizers something to hang their helmets on, the Policy continues on to suggest that "there are, however, very useful intermediate steps that will allow the development and testing of key technologies and experience in space industrial operations to be gained. The U.S. will pursue an evolutionary program that is directed toward assessing new options which will be reviewed periodically by the Policy Review Committee (Space). The evolutionary program will stress science and basic technology—integrated with a complementary ground R & D program—and will continue to evaluate the relative costs and benefits of proposed activities."

"More and more, space is becoming a place to work—an extension of our environment."

As for the Space Shuttle itself, the Carter Administration appears willing to support incremental improvements in the Shuttle's system, with "decisions on extending the Shuttle's stay time in orbit and future upper stage capabilities (e.g., the reusable space tug and orbital transfer vehicle) to be examined in the context of our emerging space policy goals.

Following on the heels of Carter's Policy comes S. 3530, a bill introduced by Senator Adlai Stevenson III (D.-Ill.). Stevenson's "Space Policy Act of 1978" calls for extensive use of the Shuttle during a 10 year period for "the design and construction in space of a first generation of structures for the purpose of communications, remote sensing, experiments in electric power generation, human habitation, and other applied and scientific uses."

Solar power satellites are discussed in the Senator's bill which entails "the design of prototype systems for generation of electric power to be transmitted to Earth and, upon a favorable determination of the effect on humans and the environment and favorable economic and reliability comparisons with alternative energy systems, testing in space of such prototype systems." Not quite a full blessing, but a start. Additional trappings of the Stevenson policy include standard support of space science and Earth-oriented application programs.

By far the most wide-ranging space policy bill comes from someone who has been out there and back, Apollo 17 astronaut, and now Senator, Harrison Schmitt (R.-N.M.).

Schmitt, who just barely squeezed out the bill before Congress locked its doors until next session, details a 30 year plan that would make every space-hungry colonizer sign up for action. Labeled "The National Space and Aeronautics Policy Act of 1978," Schmitt's policy is based on a "World Information System," an "Orbital Civilization," and a "Second Solar System Exploration Decade." These building blocks would be integrated with "the development of other space and aeronautical activities in order to preserve and expand the leadership of the U.S. in space."

Schmitt's bill is largely based on a speech he presented in late September at the annual gathering of the Institute of Electrical and Electronic Engineers (IEEE). At that time, Schmitt called the Carter Administration's "no-vision" policy for space a "disaster." "Rather than exerting the leadership that the American people and the world expect, Carter has continued and appears on the verge of accelerating the policies of retrenchment begun by Nixon," asserted Schmitt.

In his space policy plan, Schmitt focuses on a space cooperative consisting of private, governmental and international ventures to the year 2010. The first phase, to the year 1990, calls for the creation of an operational "World Information System," which includes expanded telecommunication operations and a weather & ocean forecasting network, coupled with an operational Earth resources monitoring system.

By the year 2000, basic facilities and capabilities will be developed to create an "Orbital Civilization" in the near-Earth space. These facilities will foster orbital research, space and Earth power production and generation, education, manufacturing, health care, and "space recreation opportunities for as broad a spectrum of human beings as possible."

Senator Schmitt's policy states that by the year 2010, a base with eventual permanency will be constructed on the Moon; exploration of Mars with establishment of bases on the red planet will have been accomplished along with missions of explorers to the planet Venus. The settlements on the Moon and Mars would be, in part, if not largely, supported by the commercial sector, becoming self-sufficient within 10 years or less.

Space observers categorize Schmitt's policy as over-ambitious. "He's still a newcomer to the game," states one Capitol watchdog. Others see the Stevenson policy as more palatable, established on "fiscal realities of the day." Some call Carter's space policy as the best to expect, given the economic climate of the country, and see a need for cost & technical evaluations of Shuttle capabilities. In other words, the Office of Management and Budget holds the reins on future space growth.

An important element which runs through all three policy statements is the ever-increasing concern of maintaining America's world leadership in space, while establishing and fostering cooperative international space projects. Also, with the rise of anti-satellite testing, the policies promote the assurance that space will remain safe and peaceful, void of claims of sovereignty.

Carter's Pilgrimage To the Stars

By Leonard David

"I am often asked about space factories, solar power satellites and such other large-scale engineering projects in space. In my judgement, it is too early to commit the nation to such projects. But we will continue the evolving development of our technology, taking intermediate steps that will keep open possibilities for the future."

So said President Jimmy Carter, October 1 at the Kennedy Space Center in Florida. Celebrating his 54th birthday and NASA's 20th, Carter reflected on the past and future of the space program during a twenty minute speech before several thousand Space Center workers and their families.

The occasion also marked the presentation of the first Congressional Space Medals of Honor to five veteran astronauts and the widow of Virgil Grissom who was killed in the testing of an Apollo spacecraft in 1967.

In general terms, the President lavishly praised the Nation's space program, stating ". . . there is nothing in scientific and technological experience to compare with the enormous leaps we have made in the brief span of the two decades of the space age. We have performed what any generation would have considered miracles. We have taken the stuff of fantasy and dreams and we have turned it into accomplishment and reality."

Carter paid tribute to a wide range of space projects, from the Apollo program to Skylab, Pioneer 10, and the Viking landings on Mars, but focused primarily on the new view spaceflight has given of our planet Earth. "Through the eyes and the cameras of the astronauts," commented the President, "we saw our world as a single delicate globe of swirling blue and white, green, brown, from the perspective of space; our planet has no national boundaries. It is very beautiful, but it is also very fragile. It is the special responsibility of the human race to preserve it. Of all the things we have learned from our exploration of space, none has been more important than this perception of the essential unity of our world."

In contrasting the last two decades of space exploration with the Shuttle era, Carter emphasized that the future looks ". . . as exciting as anything that has gone on before." "With the ability to lift a payload of up to 32 tons into orbit on mission after mission, the Shuttle will give us regular frequent and economical access to space. Like the sea, the land and the air, space will become an environment in which human beings can live and work for the welfare of their own species," the President stated.

Quoting a $100 billion pricetag for our American space program to date, Carter remarked that "it is now time for us to capitalize on that major investment even more. We have already reaped many practical benefits from space. Over the next generation, these benefits will increase geometrically."

While casually tipping his hat to communication, weather, and Earth resource satellites, and the services they render, Carter dropped a diplomatic bombshell by acknowledging publicly this country's use of spy-in-the-sky satellites. Becoming the first President to officially announce their existence, Carter called them "an important stabilizing factor in world affairs in the monitoring of arms control agreements." He also stressed their "immense contribution to the security of all nations. We shall continue to develop them."

With a backdrop comprised of a towering simulator of the Space Shuttle, the President stood within the space center's huge, eight-acre Vehicle Assembly Building and described the period of Saturn-Apollo missions as "pilgrims in space, ranging far from home in search of knowledge. Now we will become shepherds tending our technological flocks, but like the shepherds of old, we will keep our eyes fixed on the heavens."

For the 1980's and 1990's, Carter said that the United States will continue direct investigation of our solar system and, using the space telescope, new discoveries may lead to a "... quantum growth in our understanding of the basic nature of time, matter and energy." In the closing moments of his presentation, the President declared that "in the coming generation, the scope and the range of our space activities will reflect the range of our requirements and interests as a vigorous, responsible and free society. Those activities will be measured against all the needs of our country. We will be encouraging other countries to participate both in the work and in its benefits. But we will not give up the leadership of the United States in space."

Leonard David is Director of Programs for the Forum for the Advancement of Students in Science and Technology.

Announcements:

4th Princeton/AIAA Conference on Space Manufacturing

Call for Papers

The 4th Princeton/AIAA Conference on Space Manufacturing will be held at Princeton University May 14-17. Topics to be covered include:

space manufacturing facilities
trajectories
asteroidal resources
propulsion and mass drivers
chemical processing
industrial operations
systems, economics and products
habitat design & scenario development
life support and space agriculture
life sciences
social sciences and humanities.

Abstracts of papers are due by Jan. 12. Authors will be notified of acceptance by mid-February. March 16 photo-ready manuscripts are due.

Send abstracts to: Prof. Gerard K. O'Neill, Princeton University, Box 82 Princeton, NJ 08540.

$2,000 SPACE SCHOLARSHIP OFFERED BY NATIONAL SPACE CLUB

The National Space Club has announced that they are offering a $2,000 scholarship for studies in the field of space research for the 1979-1980 academic year. Applicants must be U.S. citizens in either their junior or senior year of college.

Anyone wishing to apply for the scholarship should send the following:

1. Transcript
2. Letters of recommendation from faculty members.
3. Accomplishments which demonstrate personal qualities of creativity and leadership.
4. Scholastic plans.
5. Personal financial needs.

Applications must be sent before January 15, 1979 to this address:

Mr. James M. Murray
c/o National Space Club
Suite 700
1629 K St. N.W.
Washington, D.C. 20006

The lucky winner of the scholarship will be announced March 30, 1979.

$100,000 Mitchell Prize

Houston, Dec. 11, 1978 — Guidelines were announced today for the 1979 Mitchell Prize, which offers $100,000 in cash to individuals "demonstrating the highest degree of creativity in designing workable strategies to achieve sustainable societies."

The Mitchell Prize, established five years ago by George and Cynthia Mitchell of Houston, will be presented at the third Woodlands conference on Growth Policies, which is scheduled for Oct. 28-31, 1979, at The Woodlands, a new town near Houston.

One first place award of $10,000 and eight awards of $5,000 each will go to winners of an open competition which seeks to encourage "creative, constructive thinking about the nature of sustainable societies."

Another $50,000 will be given for specially prepared papers on themes directly related to the agenda of the 1979 Woodlands conference. These papers will be commissioned by the conference sponsors.

The Mitchell Prize is being administered by the University of Houston System, and winners will be selected by an independent panel of judges. The first round of judging will be based on written summaries of proposed entries, which may take the form of research, a scholarly paper, film, engineering drawing, working model, computer model, or any other appropriate medium. Maxium length of each summary, which must be in English, will be 2,500 words. Initial entries must be postmarked by Feb. 28, 1979.

Background information, significant rules and application forms — which must accompany all entries — are available from: Woodlands Conference, University of Houston, 312 C & O, Houston, TX 77004.

Participation in the Mitchell Prize competition is being encouraged in more than 150 countries around the world. In addition to receiving cash awards, the winners will be invited to take part in the Woodlands Conference on Growth Policies, and their papers or entries will be included in publications that are expected to emanate from the October 1979 meeting. The conference is part of a ten-year series of international biennial assemblies aimed at stimulating research and discussion into problems associated with growing demands for the earth's available resources.

Congress Views Space

by Paul J. Werbos

Congress is taking a serious look at space. Proper information could be a key factor to the outcome.

This year, the economic exploitation of space has "taken off" in Congress. Many bills were introduced last year, and many bills are planned for next year, to make sure that the full economic benefits of space are actually realized.

So far, it has been a case of idealism and science colliding with political and economic reality. No major bills have passed so far, though many have come close. The Maryland Alliance for Space Colonization (the regional branch of L-5) has been closely involved in many of the discussions between supporters of space and Congressional advisers. It is our impression that really major bills *can pass* this year, if we face up to the lessons of the past year. MASC has learned lessons in three broad areas—grand strategy, strategy and tactics—which may be of use to other branches of L-5.

First, grand strategy: what kinds of bills will really lead to the exciting kind of future advocated by O'Neill?

One thing we should *not* do is maximize the number of bills passed; major speeches by the President might help focus attention on the "vision" of space, but bills which "support" space without mandating action or funds are not likely to be of much value. Furthermore, bills which require government departments to assess the possible value of space for their department may generate a lot of last-minute guesswork but very little serious analysis, unless funds and procedures are specified.

Second of all, we must not imagine that every dollar voted for space will really help our long-term goals. There is a definite parting of the ways shaping up between Glaser's current concept of Earth-launched Space Solar Power Satellites (SSPS) and O'Neill's concepts of the "high frontier." For awhile, it looked as if Glaser's concept might be a useful here-and-now steppingstone to O'Neill's goals. No one expects Congress to commit us to O'Neill's concept of large-scale space habitats; people in NASA are almost paranoid about the public relations aspects of the idea.

However, there is a better steppingstone available: the notion of space manufacturing. Space manufacturing, even with the use of extraterrestrial materials, is much closer to the real world, as perceived by NASA. O'Neill's schedule for space settlement (Astronautics, March and April 1978) requires that we concentrate money in these two areas—space processing and extraterrestrial materials—for several years and for billions of dollars into the future, before we do anything more. A serious program of space industrialization would *fully implement* this schedule, just as efficiently as if O'Neill himself were free to spend the money on his own plan. It is a perfect steppingstone.

> *...bills which "support" space without mandating action or funds are not likely to be of much value.*

On the other hand, the Glaser plan may be a very poor steppingstone. First of all, it does not put any money at all into the two major areas required for O'Neill's objectives. If the concept ever received funding on a large scale, this would commit our country to heavy expenditures on space which *do not* help us reach our long-term goals; it would make it much, much harder to get the billions we need.

As long as we are discussing small-scale funding, however, we do have something to gain by establishing a coalition with Glaser supporters; the present Sunsat bill may allow funds to be divided between the Glaser and O'Neill versions of SSPS, and it can be very helpful with the problem of energy transmission as opposed to power generation. Even the aerospace companies now behind the Glaser concept are likely to become open to better alternatives, if they decide that people in Congress are serious about wanting to look at the alternatives.

So much for the grand strategy. If we can agree that space manufacturing, with the use of lunar material and the option to build SSPS in space, should be our main priority, then how do we convince Congress?

North American Rockwell has put together a detailed report on the possibilities of space manufacturing. This report has excited a number of Senators, who have begun to write bills to implement the Rockwell plan. The report has been studied by a number of high-level government economists, who have come back with some very hard questions. In facing these questions, we must remember that most people in Congress have not really made up their minds about space activity; if we treat people as enemies simply because they ask questions about incomplete arguments, then we will generate enemies.

The biggest three problems they found with the Rockwell report were as follows: (1) Why shouldn't private industry pay for all these programs, if they are indeed profitable? Since private industry has enough money for each small project, since it has more technical expertise than the government does in manufacturing, and since they are maximizing profit in a way which reflects the national economic interest, then why should the government become involved? (2) Isn't the discussion of jobs and economic multipliers an appeal to the naive and the pork barreller? Yes, there is a "multiplier effect" in getting new jobs, but couldn't we just as easily spend the money somewhere else (or in a tax cut) to get the same effect? There are so many small, unrelated options that it begins to look like a "fishing expedition" or a "Christmas tree wish list," The political and economic issues with *each one* of the manufacturing options require detailed analysis, and a bill which incorporates a more complete plan than just dollars for hardware.

After an analysis of the Rockwell report, and of preliminary versions of new bills, these economists did *not* come up with a negative view of space manufacturing on the whole. However, they felt that legislation should be written in a different direction, to emphasize the real economic possibilities of space manufacturing rather than the current interests of technical people. Also, they felt that there should be new reports and analyses to fill the holes on the economic side. They emphasized three large economic payoffs which can justify large-scale government spending on space manufacturing:

(1) An *"insurance policy"* in the energy field. There is no source of energy at all which is *guaranteed* to produce energy at a bearable price, safely, in adequate quantity, when the world supply of oil begins to get tight. Thus it is a major national goal to try to minimize the probability that our economy falls apart 20 or 30 years from now. Well-trained economists recognize that classical interest rates and capital theory *do not* adequately recognize this kind of objective; thus private companies, acting on classical incentives, do not have enough incentive to minimize this probability.

Space manufacturing opens up *two* energy options (or more) for the price of one: (a) SSPS made in space, as suggested by O'Neill; (b) large quantity, low cost manufacturing of solar cells for use in space or *Earth*.

Uncertain as these payoffs may be, these options still have a major value as a "hedge" against the failure of fusion, the thorium breeder, etc., to work out at a low enough cost. The "insurance policy" approach would also argue for expanded funding for other alternate energy sources, not a reallocation away from them to space.

When it comes to supplying the entire U.S. and the world, we can afford only one major source of electricity, not dozens of options; however, for medium-scale demonstration, it is essential that we *do* develop as many options as possible, so that we can be sure that the best option will be known and available to us to supply our expanding needs quickly. It was strongly recommended that these points be developed in detail, both to minimize the "fishing expedition" impression and to put ourselves on firmer economic ground.

(2) *Spurring innovation* in US industry. Due to a lack of competition, legal problems, and many other factors, the rate of innovation and research has declined dramatically. These "structural problems" reduce industry's ability to exploit *any* opportunities for innovation, in space or on Earth. Many top economists are very scared about what Japanese, Europeans and even Russians might do to our economy five to ten years from now; the present problems of the dollar could become the first push of a tidal wave.

In the 1960's, NASA established a large, firm and measurable record as a stimulus to innovation. (Some economists ascribe *half* the innovation in the US economy in that period to NASA stimulation; indeed, one need only think about microcircuitry, and what has happened since NASA phased down, to see that this makes sense.) A broad-based program of research in manufacturing techniques, coupled with an applications program, is certain to work as well or better than Apollo in this area. Other strategies have been tried, but none of them has been nearly as effective as NASA. At any rate, a program in space manufacturing would complement other strategies to spur innovation, not compete with them.

. . .extra spending on space manufacturing may create or maintain jobs, not inflation.

A "NASA" strategy, unlike a simple taxbreak strategy, would make it realistic for small new firms to sell products or exploit techniques which the larger companies stall on. Given how urgent the innovation problem is, it is important that the "NASA" strategy to spur innovation has been tried and proven to work on a large scale; any attempt to use a watered down version of this strategy would risk failure.

(3) *Mobilizing resources and helping us adapt to lower defense expenditure.* A dollar of government expenditure generates two or three dollars of demand. This "multiplier effect" is about the same with space as with any other area of government spending; thus it is not true to say that "space generates more jobs because of the multiplier effect."

It is realistic to expect that space will create more jobs, but not because of the multiplier effect. In technical terms, there is an issue called "sectoral balance." When you spend a dollar to pay a salary to someone who otherwise would be unemployed, you generate more work and more output. When you spend it to buy something which is already being produced at maximum capacity, you bid up the price; you generate inflation, not more production. (Also, secondary demand can be "tuned" to make sure we get 100% benefit from the difference.) *The only real "cost" of* government spending is the inflation which it generates; when you can use the money to mobilize unused resources, the real "cost" is mostly an illusion. In the aerospace sector, it seems likely that the nation still has unmobilized resources, and will continue to have them, especially if we continue to reduce weapons expenditures as a percentage of GNP. Lunar materials certainly constitute a large unmobilized resource, central to what we are proposing.

Aeropspace people *could* be given employment in make-work projects, in places like Seattle and California, but their output under those conditions would not be nearly as high (in "dollars", which is the basis of our program cost evaluation) than it would be in their own field. Thus *even when total government expenditure has reached inflationary levels in the social services sector, extra spending on space manufacturing may create or maintain jobs, not inflation, in addition to providing direct economic benefits.*

Finally, the Congress is very concerned about international cooperation, finding a role for the Third World without upsetting them, etc. Some of these questions are so complex that they should be explored *concurrently* with the technical research, and given significant funding as part of any space manufacturing bill. Perhaps as part of any new space bill, the President should receive an explicit mandate to negotiate the possibility of internationalizing some or all of these efforts at the earliest possible time, with "ERTS" and other surveillance activities under the UN, energy-related activities connected to the International Energy Association, etc.

On the tactical level, many people have admonished us to keep 100% quiet about the idea of space habitats and to avoid at all costs concepts like "creative evolution," etc. This we have found to be a half-truth.

As a practical matter, we would now recommend a 25-50-25 strategy: 25% discussing innovation (as above) and related nitty-gritty issues; 50% discussing energy security and the "insurance policy" idea; 25% discussing O'Neill's idea, *as an option* to be kept open and as a way to overcome forever the limits to growth. Many economists in industry and labor are dead-serious about making sure that the "limits to growth" are indeed overcome.

We have found it essential to work closely with groups, like B'nai B'rith, which are seriously concerned about energy security and energy indpendence. Congress is also surrounded by hordes of social climbers, and it may be tempting for the novice to take the attitudes of these people too seriously; in general, however, it is not worth wasting time with people who care more about preserving their cliques than about the content of what you have to say.

Even a handful of articulate constituents can easily get the attention of their Congressman's staff, enough for you to be very important in the process, *if* you are willing to listen and do your homework. Even one well-written letter to your Congressperson can make a big difference. *After* you know what questions your Congressperson has about space industrialization (check his or her testimony before taking up anyone's time!), you may find it possible to serve as an "unpaid staff member" and obtain answers to these questions by your own detective work.

This spring and summer, letter-writing will be very important, both in the House and the Senate. Those of you who are willing to learn to become speakers should plan now to sharpen your skills, and try to be ready to speak to a variety of other groups and clubs this spring; in this way, we can get letters or letter signatures from many more people than L-5 members proper.

US Space Legislation Roundup

Solar power satellites ended up with $2 million more than OMB's request; the extra money is attached to the NASA budget, a compromise between the House's $3 million and the Senate's none. This is in addition to the $3,341,000 DOE is spending in-house in FY '79 and $1,300,000 it is contracting out through NASA.

Advanced Programs had $2 million tacked on to the OMB $5 million request, bringing its FY '79 funding up to the level of FY '78. This is less, however, than the House request for a total of $12 million, the size of the FY '77 budget.

Search for Extraterrestrial Intelligence received $2 million, in spite of "Darth" Proxmire's Golden Fleece award.

Lunar Sample analysis had $4.5 million cut from its budget.

Spacelab II lost $1.2 million.

The teleoperator retrieval system received the entire $20.5 million of the Senate request. However, NASA may only commit $10 million of this until it can prove that Skylab can be saved.

The "High Frontier" amendment passed, but the money appropriated with it was deleted. Chances that the heads of NASA, NSF, DOE and the President's science advisor will approve diversion of of NSF's funding to space colony research are almost nil, according to a House Science and Technology committee staffer.

The Solar Power Satellite Research, Development and Demonstration Act died in the Senate committee. Rumor has it that the chief staffer for the Energy R&D Subcommittee, Pete Smith, wrote Sen. Abourezk's anti-SPS testimony. Please note, however, that arguing with a Senate committee staffer is usually worse than hopeless.

The "High Frontier" resolution, HR 451, also died in committee.

A $4.5 million general reduction in NASA's budget was mandated. However, Congress required that no cuts be made in any of the programs whose funding they had increased over the OMB request.

If you would like to receive first class mailings on actions in the US Congress, write to the L-5 Space Legislation Hot Line, 1620 N. Park, Tucson, AZ 85719.

Inside the L-5 Society

Space Farm Topics

Future space farmers will want to attend the annual meeting of the American Association for the Advancement of Science in Houston January 3-8. Jack M. Spurlock of the Georgia Institute of Technology is chairing a session on "Agricultural Systems for Space Habitats" Jan. 6 in the Houston Marriot Hotel. Papers will be presented by Mike Modell and Marc Karel of the Massachusetts Institute of Technology, John Phillips of Arizona Research Associates, and David Draper of North Carolina State University.

Vancouver L-5

Ms. Camile H. Dionne is interested in starting a Vancouver, B.C. local chapter. If you wish to help with the project, please call her at (604)987-3940 or write to her at 51 S. Hendry Ave., North Vancouver, B.C. V7L 4C6, Canada.

West European L-5

The West European Branch has had offers from members willing to start up groups within Germany and Finland. Any members wishing to assist or simply join the new groups are asked to contact either:

Uli Lochner, Pfaffstr 16,
7500 Karlsruhe 41
West Germany
or:
Ari Harenko
Valskarinkatu 1 B 43
00260 Helsinki 26
Finland

Northwest Chapter

Members of the Northwest L-5 Society were unhappy to note that we were not included on the list of local chapters in the October **L-5 News.**

The Northwest L-5 Society currently has 35 members in the Seattle and Western Washington area and meets on the third Wednesday of each month, usually featuring a speaker on space industrialization. We'd like other interested persons in the area to join us. We also publish a monthly newsletter which gives the times and locations of upcoming meetings and events. For further information contact:

NW L-5 Society
c/o Tom Buxton
928 18th Ave. W.
Kirkland, WA 98033
(206) 822-5979
or
c/o Hugh M. Kelso
550 Bellevue Way SE.
Bellevue, WA 98004
(206) 453-1139

Virginia Tech

Virginia Tech L-5 has a new on campus address:

VA Tech L-5
c/o Cindy Hartman, President

4038 West A.J.
V.P.I. & S.U.
Blacksburg, VA 24061

High Frontier

The High Frontier Society is the name of the newest local chapter. Interested members in the Pittsburgh area should write to:

High Frontier Society
321 O.E.H.
Univ. of Pittsburgh
Pittsburgh, PA 15260

Alternate Energy

"Congressional Outlook," which appears on Channel 22 (WAPB) in Washington, D.C. broadcast a program on November 14, 1978, concerning Congressional interest in alternative energy sources. The informative narrative touched on domestic solar, SPSS, windmills, alcohol, and fusion sources. Seven members of Congress (Durkin - NH, Jackson - WA, McClure - ID, Bayh - IN, Glickman - KS, McCormack - WA, and Matsunaga - HA) presented their own perspectives regarding the specifics of the sources. A five-minute discussion of SPSS including graphics and comments by Senators Durkin and Jackson was also included.

Transcripts of the program are available (specify program #106, "Alternate Energy") for one dollar from:

Congressional Outlook
1414 22nd Street, N.W.
Washington, D.C. 20037

Letters

Recently I received my copy of L-5 and was very stimulated to be able to pursue what many thought and still think to be a viable alternative for the prisoner. The article was titled "The Prisoner in Space."

David Joseph Ambrose
Prisoner No. 042347
Raiford, FL

Just a short comment about the article "The Prisoner and Space" in the October **L-5 News**. In my opinion, someone who was serving a jail sentence for manslaughter would be the last one I'd send into space. True, in the past prisoners were used to colonize new territories, but only because there was no one else who wanted to go. In the event of an L-5-type colony being started however, I seriously doubt that there would be any shortage of volunteers. The growth of the L-5 Society should be ample evidence of that.

As for the comment concerning the prisoners on death row and their willingness to go, so what's to know? Between the death penalty and a ticket into space, I wouldn't have to think it over very long! No, leave the prisoners in the prisons and let some law-abiding folks have a turn for a change.

Dan Molitar
Yakima, WA

I agree that space colonization might truly be our last frontier, but why aren't we allocating more funds for oceanographic research? True we are exploring the ocean depths, though not to the extent of the space program. Since the Earth is covered by 71% water it would seem foolish to overlook this potential human habitat. The ocean could become another frontier for habitation with the help from the Government and private industry.

Dominick Albanese
Menands, NY

I heartily agree with Michael Strong's letter in the September issue of the L-5 News. However, I suggest Sen. Proxmire be given the FIRST ANNUAL CAPON & STEER AWARD for the man who takes the most pride in castrating the American effort in space R&D.

If in the distant future SETI should get proper funding, the first ET we encounter will probably be broadcasting in Japanese or Russian.

Rhonda Allen
Benton Harbor, Michigan

Please stop this hopeless socialism of begging the government to help us! The L-5 power stations will pay good energy dividends which will be better than money in the near future. We should get started and not complain to the public or to Congress or to ourselves.

Maitland McLarin
Mountain Lakes, NJ

One thing I would like to discuss re. "Space Mines" and "Response to 'Space Mines' " is the idea that the United States agree to take only a few percent of the solar system's resources in order to get the third world countries to accept our mining of space. I would not be too quick to suggest that the United States sign away any resources from space. First of all, how are we going to decide which few percent the United States may mine in cases where there is a limited supply of some resources? But more important in the long term is the question of limited resources. That's right, limited resources even in the entire solar system. I seem to recall reading that when the New World was first being colonized people were saying that the resources would last thousands of years. And yet here we are only a few *hundred* years later with most of the New World's resources gone. I think we should recognize that the solar system's resources are not infinite and that they could be exhausted quite rapidly. In fact I suspect that they could be used as fast as the New World's were, it's only a matter of scale. Even a cursory glance at man's history should show that we have an unlimited ability to grow and expand to fit any ecological niche no matter how large. And I don't think this is necessarily bad. The more we expand, the more energy we control, the more likely we are to survive. Once the solar system's resources are gone we can always look to the stars (see the British interplanetary Society's **Project DAEDALUS** book just out—a description of an unmanned starship probe that could be built with technology not too far in advance of the present state of the art. This book represents the work of many engineers and scientists during the last few years and is well worth getting (and recall that the BIS in the 1940's did much of the preliminary research that made Apollo possible)).

Because of the above I would like to suggest that the L-5 Society not plan on disbanding the minute we reach L-5. There will still be work to be done. For instance, I can easily see a solar system civilization being unwilling to conduct interstellar exploration and colonization for many of the same reasons that the United States is unwilling to conduct planetary exploration and colonization. And in many ways interstellar colonization is much more important than interplanetary colonization (except as far as the second must come before the first is possible).

Donald Robertson
Sacramento, CA

Have you noticed the amount of copy and *editorial support* the **Christian Science Monitor** has given to the space program in the last six months? It never misses a chance to urge SPS, mining, and exploration. It might be worthwhile to pass the word on to members. It is an all around excellent daily paper that is received in the mail daily by subscribers.

William Cole
Portland, OR

L5 NEWS

January 1979

L-5 NEWS

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Alcestis R. Oberg, Editor

Jennifer L. Atkins, Assistant Editor

Carolyn Henson,
William Weigle,
Administrative Services

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1 **Soviets in Space** *After the Russian's record-breaking year of 1978, the* **L-5 News** *looks into the Soviet space effort.*

2 **Soviets Overcome O-g Problems** *With 140 days in space, Cosmonauts Kovalenok and Ivanchenkov make medical history.*

4 **Unexpected Psychological Benefit on Salyut-6**
Life for the Moon
Plants in a Moon Life-Support System
"Oazis" Experiment

5 **Eggs in Space**
Life Support Systems Aboard Salyut-6
Circadian Rhythms on Salyut-6

6 **Soviet Space Station Activities, 1979**

7 **Russian Plans for Space Stations**
Feoktistov on Future of Orbital Stations
Space Power Stations

8 **Development Prospects of Space Facilities**

9 **Heading for Unknown Worlds** *In an interview, Konstantin Feoktistov describes what he sees in the near future for space exploration.*

10 **Cosmonaut Feoktistov Comments on G. O'Neill's "Space Colonization"**

11 **The Cosmo 954 Incident and International Space Law** *Will the crash of Cosmos 954 repeat itself with Skylab? Alcestis Oberg looks at the problems and solutions in this precedent-setting case.*

12 **Thoughts on the Tenth Anniversary of the First Moon Flight** *By James Oberg. Was there really a 1960's "space race"? How close did the Russians come?*

13 **Industry Leery of Production in Outer Space** *by Dave Dooling*

14 **News Briefs**
Latest Shuttle Schedules
Chinese Space Station by 1986 *by Dave Dooling*
French Space Shuttle *by Dave Dooling*

15 **Of Interest**
Institute for the Social Science Study of Space
SPS Research Topics
Space Settlement Shows

16 **Book Reviews** *At last a novel about a future L-5 Community! Reed D. Riner of Northern Arizona reviews Ben Bova's* **Colony.**

17 **Letters**

Cover: The view that you will have when returning to your space colony in cislunar space after a vacation on Earth.

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Soviets In Space

Fanciful Soviet cartoon of future space gardens.

EDITOR'S NOTE: 1978 has been a significant year for the Russian space program. With the operations of the Salyut 6, the Russians have moved into their "second generation" of space stations: they have had more launches, more visits, more activity in this one year than in the previous six; they now hold the records for the longest space flight, greatest number of total man hours in space, and have broken previous Salyut altitude records. And the Russians have been thinking of the future, as well, although these news items are not very well publicized in the West. **L-5 News,** *therefore, is dedicating a large portion of this issue to the Russian space effort and to the significant and far-reaching research that the Russians have done in exploring the habitability of space.*

Soviets Overcome O-g Problems

Nov. 2, 1978, Cosmonauts Vladimir "Volodiya" Kovalenok and Aleksandr "Sasha" Ivanchenkov returned from their record-breaking (139 days, 14 hrs., 48 min.) Salyut-6/Soyuz flight. After 2 weeks of intensive study of medical data gathered during and after their marathon flight, Academician Oleg Gazenko, in a speech at Moscow State University, gave this report:

During the preparatory period, in the course of this 140-day flight, and now after its completion, both the cosmonauts and the specialists who worked on the medical safeguarding of this flight must carry out very serious analysis of the very voluminous and very important scientific material which, it can already be said, will significantly expand our ideas of space and the people who conquer it. Naturally, this data still requires more analysis, more serious study and evaluation, so today I can present only the very first observations and some of the first results of this material.

It must be noted that during this prolonged flight, the crew not only completely fulfilled the mission's scientific program but, in many important areas of that program, overfulfilled it, especially in the area of medical and biological research. The scientific program, as you know, was exceptionally broad, variegated and intense. It included: many scientific and technical experiments, the fulfillment of various technical tests on the numerous systems on board the orbital complex, work connected with servicing the station itself, the repair of equipment, and, finally, constant communication with the flight control center. But I should like to point out the remarkable fact that as time went on, the crew's work capacity actually increased in comparison with the initial flight period.

We are gaining the impression that there were several circumstances contributing to this fact. First, there was the punctual fulfillment by the crew of the work and rest regimen which they helped to draw up. There was wider crew participation than has previously been the case in the planning of future operations. And there was the quite successful adaptation by the members of the crew to the specific, unusual conditions of living and working in weightlessness.

It would perhaps be relevant to note here that, as distinct from certain previous observations, the initial adaptation to weightlessness was free of unpleasant sensations except for one, the sensing of a certain flow of blood to the head. And this adaptation was completed in the first 2, or apparently no more than 3, days. It is quite possible that this may be explained first of all, by certain individual physiological features of the men and, secondly, by all the training exercises which they carried out during the preflight period.

Periodically, throughout the flight, detailed medical research was carried out on specially allocated days. This research was carried out both when the cosmonauts were in a state of rest and when various stressing tests were being carried out. The cosmonauts were exceptionally sensible and creative in fulfilling that great and not always pleasant work, involving such tasks as taking samples of their own blood and carrying out biochemical research. Also, the medical research program was complemented by certain new aspects which were not in previous flights. Thus, for example, they carried out so-called dynamic electrocardiography, that is continuous recording of an electrocardiogram for 24 hours, which has considerably broadened our ideas of the reactions of the human body and the cardiovascular system to the effect of flight factors at different periods of flight. A great deal of other research was also carried out, in particular, research into such parameters as gustatory sensitivity, hearing thresholds and many others.

> *As they became accustomed to weightlessness, a new coordination of motion... became established.*

We knew that the prolonged effect of weightlessness could have an adverse effect on a whole series of systems of the human body: primarily the cardiovascular system, the bone joints, the metabolism and the state of the blood.

Electrocardiograph research, conducted in detail during the flight, did not show any deviations from the norm throughout the flight. Functional tests at dosed physical stresses and also with the application of negative pressure to the lower part of the body also showed that these reactions were adequate and, most important, showed that no negative dynamic was noted. With the passage of time, the responses to these tests did not worsen.

The objective signs of redistribution of the blood, revealed by rheography, were observed with particular acuity during the initial phase of the flight. It was possible to register the refilling of the vessels in the head and in the upper part of the body, and the depletion of the blood in the lower part of the body, particularly the legs. These readings leveled out somewhat in the middle part of the flight, but, all the same, continued to the end, although, as the cosmonauts will relate, this did not cause them any unpleasant subjective sensations.

As they became accustomed to weightlessness, a new coordination of motion naturally became established. This provided enough efficiency for the fulfillment of all necessary working operations. An analysis of the television images obtained on Earth was conducted, and indicated that comparatively soon, at least by the end of the first month, these movements were being carried out rapidly, precisely and with confidence.

With the passage of time, a reduction in the volume of the lower limbs was registered, in particular the crus which, as is known, indicates the loss of a certain part of the fluid, components of the lower limbs and part of the muscle tissue.

Thanks to the use of the measurement mass of the body (inasmuch as weight in weightlessness can be measured), it was possible to obtain an impression of the dynamics of the weight of the cosmonauts and, in a certain way, to regulate this parameter by alterations in the quantity of food and water intake.

Naturally, the study of the state of the blood was particularly intriguing for us. The point here is that the average duration of life of the erythrocytes, i.e. the red cells in human blood, is 120 days. In the course of 120 days, our red blood corpuscles are completely changed.

From experiments conducted previously during space flights, it was also known that in the course of a space flight of shorter duration, there was a reduction in the number of these cells, which are very important to us. They are the carriers of oxygen in our organism, and in the tissues. Therefore, research into the blood system was of great interest and great importance. I can report that the control samples which the cosmonauts took by themselves during the flight and which were delivered to Earth and subjected to appropriate analysis here, showed only a very moderate reduction in the number of erythrocytes and hemoglobin—considerably less than the values which we had obtained earlier even in shorter flights.

The specialists who have analyzed this data believe that this obviously positive result can be connected with the fact that the cosmonauts did, apparently, lose less of their circulatory blood than those who had flown earlier. This was partially made possible by the fact that they maintained the consumption of water at a sufficiently satisfactory level and fulfilled an adequate volume of physical stresses, which assisted in the preservation of the volume of the erythrocytic mass of the blood.

The complex of physical exercises was carried out by them practically every day during the whole of this prolonged flight, for approximately 2 hours each day. To give you an idea of the volume of work carried out during this time, I might say that they were running at a speed of eight to nine kilometers per hour. If we were to transpose this into useful work, so to speak, then the energy spent would be equal to climbing a skyscraper over 200 stories high. For you and I, who have never gone into space, it is difficult to imagine the efforts which one has to expand in order to execute such intense work in a weightless environment. However, the crew brilliantly fulfilled this task.

The cosmonauts displayed a great sense of observation. They have collected a great deal of interesting and important data, the further analysis of which, together with the proposals they have made, will undoubtedly serve to improve the methods of maintaining physiological well-being in future prolonged space flights.

In general, I would say that it was precisely this scrupulous adherence of the crew to the daily schedule prevailing on board, with a sufficiently elastic, variable planning of extensive and intense work, together with very meticulous and competent fulfillment of the corresponding prophylactic and sanitary-hygienic measures, which helped the crew preserve good health, a high working ability and an even mood during the whole marathon flight.

The cosmonauts themselves have, in the main, evaluated their feelings and general state as good. Let us note that the personnel at ground control and the psychologists were attaching great importance to the optimization of communications between the ground and the space station, and to the carrying-out of measures which were termed as "psychological support." Special issues of newspapers and videotapes with family chronicles of events, concerts and the like were taken on board. Periodic radio conversations with family members, friends, interesting interlocutors and various performers were organized. All this undoubtedly contributed to maintaining the high spirits of the crew.

Finally, as there are unavoidable difficulties with provisions, a certain variety was provided by various new kinds of produce, fresh vegetables and fruit, which were brought by visiting expeditions and transport craft.

...from the medical point of view, the principal results of this flight are that the cosmonauts underwent it well.

After touchdown the cosmonauts' reactions connected with the changeover to life in Earthly conditions, to life in conditions of gravity, were less pronounced than was the case during previous, less prolonged flights. Thus, with the apparent increase in the weight of their own bodies and all the objects they were faced with when back on earth, subsequent disproportion of movement and difficulties with coordination were observed only on the day when the flight had ended. Later on, the cosmonauts did not experience any kind of subjective difficulties or problems. On the first day after the flight, loss of weight was 2.3 kilograms in the commander of the crew, and 3.9 kilograms in the flight engineer. Restitution of weight in the commander was completed on the third day, but the weight of the flight engineer took longer to be restored, 12 days.

Blood changes were manifested only in a very insignificant lowering of the number of erythrocytes and hemoglobin, with an inclination toward the diminution of the size of these cells; but the changes which took place were without any practical significance. The number of white corpuscles or leucocytes increased somewhat. The content and level of discharge of steroid hormones rose somewhat, which is an indication of a tension reaction, quite natural in a situation of this kind. Stability with regard to orthostatic tolerance and to physical stresses diminished, but to a relatively smaller degree than could be registered after flights of shorter duration.

Research carried out with the help of ultrasonic electrocardiographs did not reveal any pathological changes in the condition of the heart, even though the quantity of blood which the heart pumps out with every beat had diminished, but to a lower degree than we had previously recorded.

The greatest attention, against the background of such a favorable condition of the cosmonauts, was drawn to changes in the sphere of motion. They manifested themselves, first of all, in symptoms of atrophy and atonicity, and also in a heightened reflex response to irritation of the muscles. The perimeter of the hip of the commander of the crew diminished by about 1.5 centimeters and the hip of the flight engineer by 4 centimeters. These changes, we suppose, were the result of adapting to conditions of weightlessness.

From the first day since the completion of the flight, the cosmonauts have been active. Their locomotive regimen has gradually increased, and I think that the chief problem is to somewhat restrain that motor activity. In order to ease their adaptation to conditions of life in Earth's gravity, we have been carrying out the appropriate measures: healing massage, walks of variable length, swimming in the pool, and so on. And the cosmonauts did not need any medicines. The so-called "severe period" of adaptation to Earth's conditions, or "readaptation", seems to have taken no more than 3 to 4 days which, from our point of view, is an extremely good result.

Briefly, one can say that from the medical point of view, the principal results of this flight are that the cosmonauts underwent it well, maintained a good working capacity, successfully fulfilled their whole program, and underwent their return to Earth conditions well.

UNEXPECTED PSYCHOLOGICAL BENEFIT ON SALYUT 6

The cosmonauts, isolated from normal life on Earth and surrounded by lifeless space, manifested a particular attachment to any organisms that grew aboard the station. This was confirmed by cosmonauts from previous missions, who lovingly tended onion stems, and fish in the aquarium, claiming that biological experiments were a pleasure rather than a work assignment. In fact it offered them a kind of emotional relaxation, and they were always ready to return to the care of their nurslings even during their "free time." On Salyut 4, Grechko especially enjoyed watching the green petals of peas growing in the "Oazis" device.

On Salyut 6, Romanenko and Grechko experimented with tadpole raising and derived much pleasure from watching the tadpoles pirouette around air bubbles in the containers. They, like the other cosmonauts of previous flights, stressed the psychological advantage of having living creatures around them.

LIFE FOR THE MOON

How the Moon can be made habitable is the subject of a brief, unattributed article in the Russian magazine, *Aviatsiya i Kosmonavtika.* Soviet scientists do not know all the answers, but certain ideas of how a normal biosphere can be implanted on the surface of the Moon are already looming.

The presence of a magnetic field is a must for any life on any planet. Radiation conditions must be created that would not harm any living organisms, hence the atmosphere must possess certain protective characteristics, above all it must have a higher molecular weight, since the gravitational potential of the Moon is six times smaller than that on Earth. A heavy atmosphere will not easily dissipate into surrounding space, and its "refilling" would become technologically feasible. It is not sure that such an atmosphere can be created, i.e., that people would be able to move around without spacesuits. Nevertheless, even if people had to wear some light-weight breathing apparatus, the atmosphere would offer protection from galactic radiation and solar flares.

Some specific lunar flora eventually would contribute to the formation of a biosphere and thus allow humankind to make the Moon the first step toward populating the universe.

POSSIBILITY OF UTILIZING HIGHER PLANTS IN A LIFE-SUPPORT SYSTEM ON THE MOON

The possibility is examined for the repeated interruption of plant vegetation by long-term darkness corresponding to the "night" on the Moon in the Russian journal, *Kosmicheskaya Biologiya.* This may prove useful for incorporating a unit of higher plants into a life-support system on lunar bases in the event of using the sun as an illumination source. To this end, cultures of vegetables (Bordeaux beets, Petrovskaya turnips, Chantanet carrots, dill, and Virovskiy white radish) and wheat (Sonora variety) were cultivated during a "lunar" photoperiod, i.e., the light and dark periods equal 15 terrestrial days. The tests convincingly showed the basic possibility of obtaining traditional plant products under conditions of the "lunar" photoperiod. It was also proven possible to use grain from wheat grown during the "lunar" photoperiod as seed material for further cultivation of these plants during this photoperiod.

"OAZIS" EXPERIMENT WITH PROTEIN-PRODUCING HYDROGEN BACTERIA

The Oazis biological system is described by Vadim Vital'yevich Kotelev, Doctor of biological sciences, Chief of the Microbiology Dept., Moldavian AS, in charge of the Oazis project, in an interview by T. I. Malinovskiy.

The system was devised to study the processes of regeneration in an enclosed limited environment, which is important for long-term spaceflights. The second model, the Oazis-2, was aboard Soyuz-13 (18-26 December 1973; Klimuk and Lebedev).

Oazis was designed for the cultivation of certain types of microorganisms. It consists of two cylinders serving as fermentors filled with liquid and gas. One cylinder contains hydrogen-oxidizing bacteria, which uses mainly hydrogen obtained from water electrolysis for their growth. The second cylinder carries bacteria capable of decomposing urea; they absorb oxygen from the first cylinder and give off carbon dioxide, which is used by hydrogen-oxidizing bacteria for protein synthesis. Hence, the Oazis system regenerates air and water and produces biomass.

The most promising method of protein synthesis is the use of microorganisms. Microbes increase their mass 500 times faster than plants and 1500-2000 times faster than animals. One 100-m^3 cultivator with microorganisms can produce in three days as much protein as two hectares of wheat, irrespective of the weather. Among microorganisms, the most promising are hydrogen-oxidizing bacteria. They feed exclusively on inorganic products and can directly convert hydrogen energy into proteins.

Studies of the behavior and properties of hydrogen-oxidizing bacteria, i.e., their biochemistry, physiology and cultivation methods, have been conducted for several years. The greatest achievement has been the production of a new strain of hydrogen-oxidizing bacteria, the thermophylic variety, growing at 50-55° C: they produce two and one half times more protein than other strains.

The property of hydrogen bacteria to capture carbon dioxide could also be used for air purification. In contrast to other, e.g. chemical, CO_2 scrubbers, microbes can operate endlessly and still produce protein.

Triple Growth in 0g

Experiments with hydrogen bacteria in space has opened additional vistas; in space, they grow three times faster than on Earth, probably due to weightlessness.

The thermophylic strain of hydrogen bacteria was obtained after long experiments of their cultivation on Moldavian mud soils. For many months, in a hydrogen medium at 55° C containing oxygen and CO_2 as well, the microorganism-rich soils had been studied. Expectations proved correct, and the thermophylic strain was finally obtained.

EGGS IN SPACE

A Soviet spacecraft, scheduled for launching in early 1980, will carry an experiment in which Japanese quail eggs will be incubated in O-g conditions. The spacecraft will return to Earth just before the eggs hatch. In discussing the experiment with a correspondent from *Literaturnaya Gazeta,* Professor Nikolay Gurovskiy noted that the Japanese quail may be used in complete, closed ecological systems for future spacecraft. Gurovskiy denied reports that Soviet scientists were also planning the birth of a child in outer space.

LIFE SUPPORT SYSTEMS ABOARD SALYUT 6:

WATER REGENERATION

In a recent report, design engineer Ye. Dunin discusses some methods of water regeneration under spaceflight conditions and describes the Salyut-6 water-regeneration system.

The refrigerating-drying units collect the condensate of atmospheric moisture and feed it into receiver-separators of moisture from the gaseous phase. The gaseous products are returned, and the moisture is pumped into columns with sorbents (ion-exchange resins) and filters (activated carbon), where it is purified of foreign matter and solid particles. Further, the water is passed through mineral filters of dolomite crumbs, artificial silicates, and salt pellets. Concentrated salt solutions are introduced according to the individual tastes of the cosmonauts.

Salyut-6 as Soyuz-27 approaches.

The water, now potable, is pumped into a tank with two cavities—for water and air—separated by a special diaphragm, which bends and forces the air out as the water is pumped in. The water can be served by increasing the pressure in the air cavity and, if desirable, can be heated. To avoid accidents, special sensors produce a warning signal if the water is not fit to drink. In that case, it can be removed automatically into special tanks.

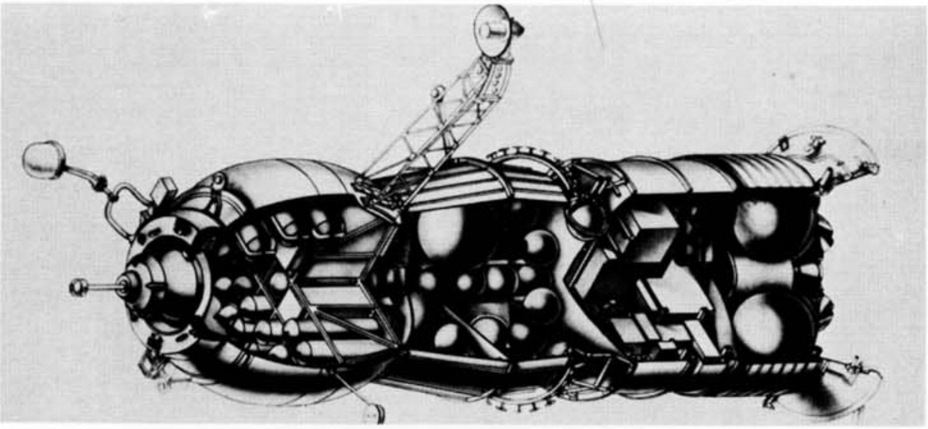
CIRCADIAN RHYTHMS ON SALYUT-6

It has already been determined that the human body cannot adapt itself to any other sleep/wakefulness regimen but the usual 24-hour rhythm. The experimental regimen of "migrating" hours, when every day the rhythm was shifted by one-half hour, as was tried aboard Salyut-4 on Klimuk and Sevast'yanov, proved to be an obstacle in the normal performance of the two cosmonauts; Sevast'yanov said this regimen was a real scourge during their mission. The regimen was also tried experimentally for 30 and 50 days on Earth, aboard a Salyut mockup, but without success.

B.S. Alyakrinskiy, a biorhythmologist, noticed that desynchronization of the circadian rhythm was an inherent component of stress states observed in test subjects. Grechko, who had been subjected to adverse effects of desynchronization and "migrating" hours during his flight aboard Salyut-4 in Jan.-Feb. 1975, praised the advantages of the normal circadian-rhythm regimen introduced aboard Salyut-6. During his and Romanenko's mission, the rest period was set at nine hours, to last from 2300 to 0800 hours, Moscow time. Romanenko and Grechko slept well, usually for 7½-8 hours; 1½-2 hours before sleep, they did not engage in any strenuous activities.

The program of daily routines worked out for the Salyut-6 crews envisaged an alternation of mental and physical work and of monotonous and emotionally creative assignments. All these activities were designed to intermingle further with physical exercises, personal hygiene, and meal times.

As a rule, the daily time quota for personal hygiene was set at 30-40 minutes; for physical exercises, 90 minutes twice a day, in the morning and in the evening, either on the bicycle ergometer or on the complex trainer, depending on the individual preference. The week was divided into six workdays and one rest day. During the rest hours, Romanenko and Grechko, to remain in high spirits, listened to the voices of their relatives, song recitals, and various debates.



Above: Internal detail of the Progress tanker/transport used to refuel and resupply Salyut-6. The forward orbital module contains bulk cargo storage cylinders, while the earlier Soyuz descent module has been replaced totally with a unit containing propellant for refueling operations.

SOVIET SPACE STATION ACTIVITIES, 1979

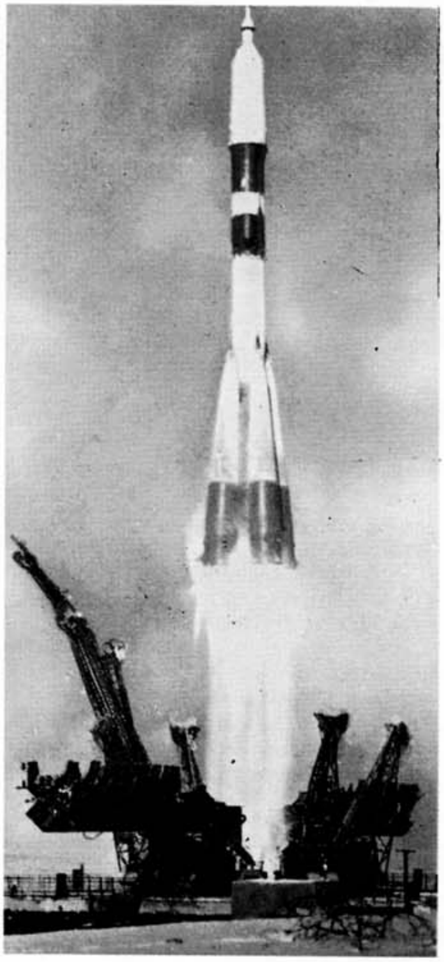
Western observers expect the USSR to resume cosmonaut visits to the Salyut-6 space station in February, with long expeditions of at least seven months duration. At the end of that time, one or both of the cosmonauts may be rotated home and replaced by fresh crew members. In parallel with the marathon expeditions and periodic "Progress" freighter resupply missions, short visits by additional non-Soviet 'guest cosmonauts' and by Soviet specialists (such as doctors, geologists, and astronomers) are anticipated. Since March 1978, cosmonauts from Bulgaria, Cuba, Hungary, Mongolia, and Romania have been in training; they were assigned to specific flight crews in November and the first should fly as early as April.

Improved versions of the Soyuz spacecraft, perhaps carrying four or five cosmonauts, may also appear, but immediate flights of the much rumored "Soviet space shuttle" are no longer expected by most observers.

Two features of the Salyut-6 which are irreplaceable and seem to have the shortest lifetime are the orbital adjustment rocket engines and the solar panels. This problem may be alleviated by the launching of another Salyut to dock at the aft end of Salyut-6, forming a permanent double station capable of hosting four to six cosmonauts. The new module would have its own orbital adjustment rockets and several solar panels to supplement the degrading panels on the original module.

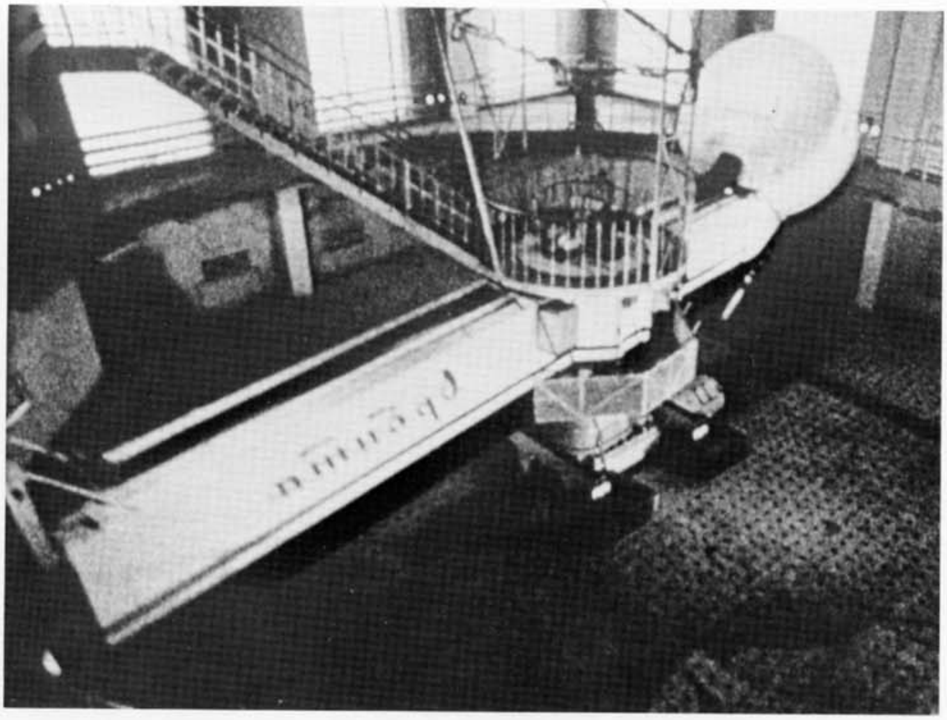
Unpiloted Soyuz ships with their "orbital modules" specially outfitted with unique laboratory or observatory equipment will also be launched, according to Soviet sources. Following a month-long program, the unpiloted Soyuz would return to Earth with special samples. Two possible candidates for such missions are the Orion UV telescope and the "Oazis" biological laboratory.

In addition to Salyut-6, other Salyuts may be launched on specialized missions such as military reconnaissance. In other words, the USSR may have two (or more) independent space stations in operation this year.



Above right: The Progress-1 at takeoff last January.

Below: A Soviet cartoon shows freight from Progress-1 being loaded onto Salyut-6. (Actual spacecraft docked at opposite ends!)



Three test engineers lived in the capsule at the end of the centrifuge arm for several weeks to study the effects of coriolis forces on the crew in spinning space stations. Project was called "Orbit."

RUSSIAN PLANS FOR SPACE STATIONS IN THE NEXT 10 YEARS

Academician B. N. Petrov reports on the future development of Russian orbital station.

Next Generation of Long-term, Large-crew Stations

Scientists are already busy designing larger stations, for a crew of 12-20, with a lifespan of up to 10 years, which would replace the present small stations. This will happen as soon as it is clear that the present stations have exhausted all their possibilities. There is no answer to the question of how often such larger stations would exchange crews. Improved methods of training and prophylaxis have already extended the period of time in space to many weeks, without any harm to health.

Rotating Stations

It is to be expected that crews will be exchanged rather frequently, until such stations have artificial gravity. This problem, however, remains unsolved: artificial gravity can be created only by rotating the station; any rapid rotation would incapacitate the crew, while slow rotation would require a much larger station (since with a slower rotation gravity can be created only far away from the axis of rotation). This seems to be one possible form of the future orbital station: large size and slow rotation, thus forming an artificial gravity where, in principle, people could live and work for many months. Rotation, even a slow one, would interfere with observation programs and would be a handicap in docking. Hence, such stations would have to be made with a nonrotating module. Under such conditions, it could be more economical to exchange the crew more often.

COSMONAUT FEOKTISTOV ON FUTURE OF ORBITAL STATIONS

Orbital stations will be developed above all as multipurpose scientific laboratories. Medical and biological experiments, making it possible to ascertain how long humans can live and work in space without harming their health, will continue on board the stations. As before, great significance will also be attached to inhabited stations for the study of natural resources—the highly effective nature of this work has already been proven by practice. It is no accident that in the past 2 years the number of organizations using space information in the interests of the national economy has doubled.

The orbital stations' unique potential will also be used for extra-atmospheric astronomical observations and for technological experiments, making it possible to obtain materials that under Earth conditions cannot be obtained at all or cost too much. In a word, in fulfilling national economic tasks, the orbital stations will also serve to seek out the most effective systems for developing methods for research and the design of scientific instruments and equipment.

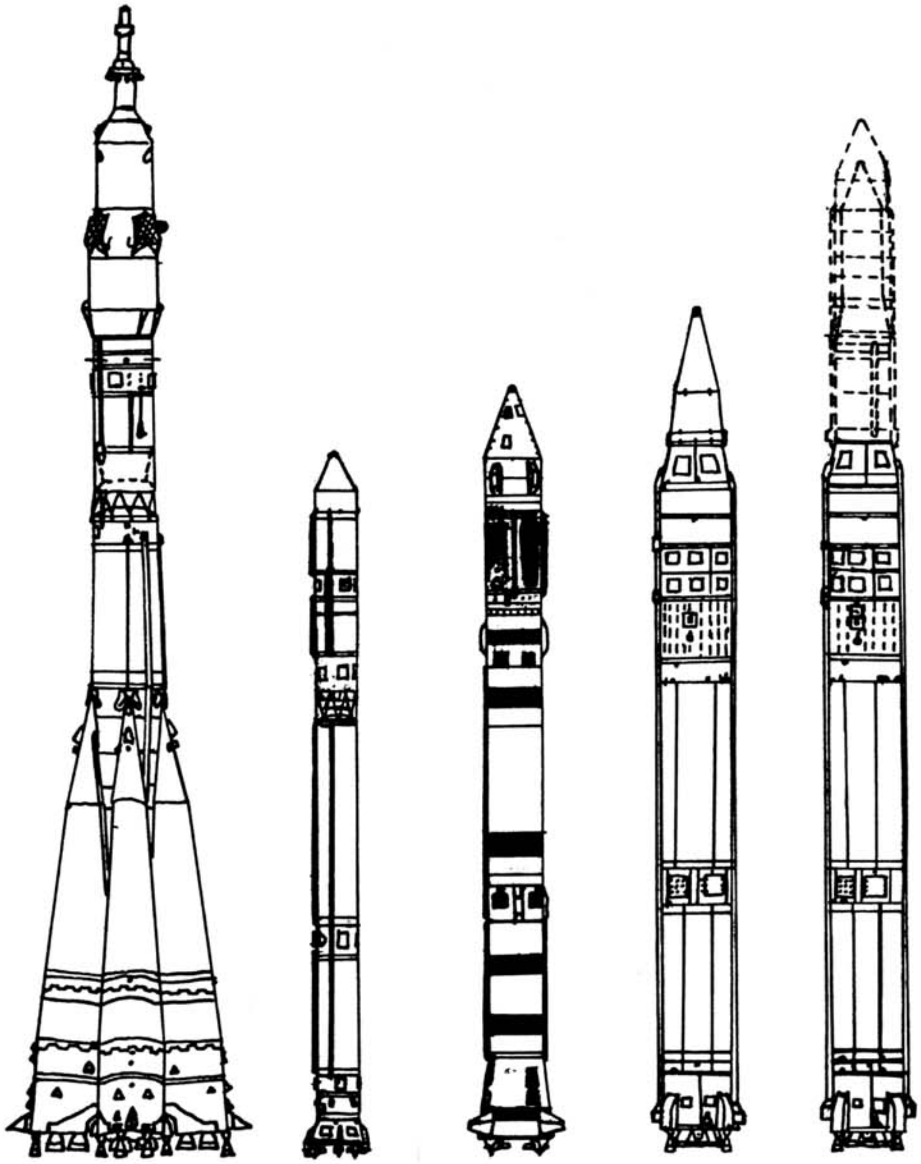
The problem of the optimal distribution of duties between human and machine is becoming increasingly topical with the increase in the duration of space flights. There is much that is controversial here. Some specialists believe that space is above all a sphere for the operation of machines. There is reason in their arguments; for instance, astrophysical observations, even in the immediate future, could be carried out with the aid of preprogrammed apparatus. Research into natural resources is also perfectly within the powers of modern radio or program controlled television equipment. But it is still people who have to elaborate the methods for this research and correlate the degree to which the information obtained by machine corresponds with the real picture.

In my view, very broad prospects are opened up for inhabited stations if they are examined above all as the basis for industrial construction in space. Not everyone shares this view, but I personally believe that within the next few decades the development of technology will make it possible to actually set the task of creating powerplants in space. These installations, gigantic by present standards and covering tens of square kilometers, will trap solar energy and convey it in transformed form for use on Earth. With time, technological experiments will lead to the creation of real industrial enterprises in orbit.

And this means that millions of tons of diverse equipment will have to be put into space and enormous and complex structures will have to be assembled there. Such work can scarcely be fully automated. Large collectives of people will control the equipment and carry out installation work. Of course, this will not happen rapidly and many people may relegate such forecasts to the realm of fantasy. But after all, 17 years ago Yuriy Gagarin's flight also seemed a fantastic achievement.

SPACE POWER STATIONS

Commenting on the projects of tapping the resources of space for the production of electricity, cosmonaut



Soviet space launch booster family which placed 1000 tons of payload and hardware into orbit in 1977 in 100 successful launches.

U.S. label	*Derivation*	*Launch #*	*Payload*
A-2	*Sapwood (SS-6) ICBM*	*54*	*7000 Kg.*
B	*Sandel (SS-4) IRBM*	*2*	*450 Kg.*
C	*Skean (SS-5) IRBM*	*28*	*1000 Kg.*
F	*Scarp (SS-9) ICBM*	*11*	*4500 Kg.*

(ICBM=Intercontinental Ballistic Missile; IRBM=Intermediate Range Ballistic Missile)

(courtesy of C. P. Vick, all rights reserved)

Feoktistov believes that the concept of space power stations is not unrealistic and may become a reality within several decades. The idea of transforming solar energy into a form that can be transmitted to Earth would require millions of tons of materials and equipment to be moved into space and hundreds of people to maintain such a system, since it cannot be fully automated.

DEVELOPMENT PROSPECTS OF SPACE INDUSTRIAL FACILITIES, NUCLEAR AND SOLAR POWER SOURCES SURVEYED

Professor O. M. Belotserkovski, director of the Moscow Physical and Technical Institute, corresponding member of the USSR Academy of Sciences, Lenin Prize laureate, was quoted in the Oct. 21 issue of *Evening Leningrad* as follows:

"What will be the next step into space? In the first place, basic research leading to the appearance of new, still unknown and unexpected practical applications of cosmonautics will be further developed. Whereas flights to the Moon and planets somewhat overshadowed other aspects of space research during the first decade of the space era, problems of studying the distant cosmos by such methods as satellite astronomy are now coming to the fore. These prospects are connected primarily with putting large telescopes in orbit.

"Trends in the development of contemporary cosmonautics indicate that scientific-and-production complexes will be built in orbit and that metallurgical, machine-building and chemical plants may be created beyond the limits of the Earth soon, possibly within the next decade. Production facilities, whose organization in Earth conditions is altogether impossible, will be the first to appear in space, of course.

"The future of space flights depends also on the creation of new rocket engines utilizing nuclear energy. The search for still other sources of energy is in progress. It is known, for example, that energy gradients on the order of several thousand volts exist in the Earth's magnetosphere. The "solar wind" contains still greater reserves of energy. Its power could impart a speed to a spacecraft on the same order as the speed of the "solar wind" itself. Then the problem of the duration of a flight also would become considerably less acute than it is at present."

Heading For Unknown Worlds

An Interview with Konstantin Feoktistov by TASS, the Soviet News Agency

Q: *What do you think a twenty-first century spaceship designed for passenger transport within the solar system will look like?*

A: I think it will be an electrical jet craft with a powerful nuclear plant that will contain a reactor and converters of heat into electrical energy—turbine generators or thermal converters. The electrical jet engines will be of either the ion or plasma type, in which a stream of electrically charged particles accelerated in the propelling device provides the necessary thrust. To keep the capacity of the on-board power unit within the limits of our technological possibilities, the engine thrust must be very small, with the result that the spaceship will accelerate very slowly, taking several months to get away from the Earth and the same time to decelerate near the planet it is headed for.

Another distinguishing feature of this spaceship will be gigantic surfaces for the dissipation of the excessive heat developed by the nuclear unit. Hence, the ship will look like a sharp-pointed triangle. At its apex will be the reactor, the radiator will be the wedge, and a considerable distance away will be the living quarters housing the instruments, control panels and crew cabins. In front of the radiator will be a shield to guard against radiation. And, finally, somewhere nearby will be a descent module for landing on the planet of destination, since the craft I am talking about will serve only for transport between planets. For landing, we need other devices of the Soyuz or Apollo type.

This spaceship is also capable of carrying research probes, putting them into planetary orbit and also landing them. You might ask why this has to be done with probes. Because it is still hard to imagine a person landing on, say, Venus.

Q: *So people and machines will participate on an equal basis in further space exploration?*

A: I would say so. For carrying out regular routine tasks—for example, collecting meteorological data, retransmitting it, taking pictures of the Earth's surface—it is simpler to use automatic devices. They can also easily land on a distant planet and do research on, say, Venus or Saturn. These tasks are easily algorithmed and programmed. People should be sent only on particularly complicated missions, for instance, laboratory research, observation of stars or the Earth in line with a selected program and to create laboratories and workshops in orbit. I think those types of projects will require the presence of human beings.

...it is simpler to use automatic devices...People should be sent only on particularly complicated missions...

Q: *What aspect of cosmonautics are you interested in today?*

A: I've been thinking more and more about whether space research can be justified economically. Many people believe that there are too many unsolved problems here on Earth to spend huge sums on space research that, they claim, does not pay off. Well, on reflection, I've come to the conclusion that we can already prove that our activity does pay off.

First, some aspects of space research work are already economically profitable. I mean the economic value of meteorological satellites, retransmission devices, TV and telegraph communication via sputniks.

Secondly, apparatus for observing the Earth from space in the interest of the economy makes better economic operation possible. For example, the two expeditions to our orbital station Salyut 4, according to the estimate of experts, saved us the economic equivalent of 50 to 70 million rubles.

Thirdly, space facilities make it possible to acquire fundamental knowledge—I mean information which cannot be obtained from the Earth—namely, about lunar soil, the appearance of Venus, characteristics of planets, electromagnetic radiation that does not penetrate the Earth's atmosphere. Thanks to space engineering, contemporary astrophysics and planetology are making considerable headway. All this helps to accumulate fundamental knowledge. And, as history shows, a purely quantitative accumulation brings about, in the long run, a qualitative explosion, a revolution in one or another field of our knowledge which, without question, will eventually turn out to be economically valuable.

And finally, we are preparing a kind of reserve for the future. Let me take two concrete examples: the creation of economically rational orbital production and preparation for the gradual habitation of outer space.

What do we need orbiting plants for? Modern pharmaceutical and metallurgical industries need superpure compounds, metals, crystals, vaccines, and the like. Here on Earth the production of some of these substances is technologically infeasible because of the Earth's gravity; in outer space the conditions for it are ideal. For instance, it is possible to purify medical preparations with the most insignificant electrostatic forces. I think that by the mid-eighties we'll be able to provide profitable and regular production facilities in the Earth's orbit.

As far as cosmic settlements are

concerned, I think these will probably be built in the future, but I do not regard outer space as an escape from the problems that humanity has not yet solved. I believe these must be solved here on Earth, although I do not rule out the possibility that in time the cosmos may become the second home of human beings. There are even a number of ideas on how to do it. One of them comes from an American physicist, Professor Gerard O'Neill of Princeton University, who is not an expert in the field of space but, as a physicist, has ideas that are both serious and imaginative about the creation of space settlements.

Gerard O'Neill suggests that artificial gravity be used in these space settlements and I, as an engineer, know that this can be done with modern technology. But it would be very expensive at the present time. Current studies and experiments are aimed at making these projects substantially cheaper and more feasible.

Another example. Academician Nikolai Semenov proposes to saturate the Martian atmosphere with sufficient oxygen so that people can freely settle on this planet. Of course, this project sounds fantastic now, but only a while ago the thought of a person walking in space seemed just as absurd.

Q: *Can we already create artificial gravity in spaceships?*

A: This is quite feasible, although I, personally, hope that people will adapt to weightlessness without injury to their health. But this is as yet only an unsubstantiated hope. Therefore, we now have to deal with a spacecraft provided with artificial gravity. I think additional difficulties are likely to occur in solving this problem. A very unpleasant phenomenon will probably be the so-called coriolis acceleration. For the near future the dimensions of spacecraft will remain comparatively small, and their rotation radius negligible. To achieve an artificial force of gravity equal to that of terrestrial gravity, a comparatively great rotational speed is needed. This acceleration has its bad effect. A person moving inside the ship will have the sensation of staggering. Similar experiments have been done here on Earth, and they tell us that people adjust to such conditions much less readily than to weightlessness. Thus, adaptation to living conditions in a rotary environment will pose its own specific problems, but it is quite realistic to assume that we can solve them technically.

Spaceflight monument in Starry Town, home of the cosmonaut detachment.

COSMONAUT FEOKTISTOV COMMENTS ON G. O'NEILL'S "SPACE COLONIZATION"

Contrary to Dr. O'Neill's belief that space settlements will settle the territorial controversy and each settlement could become completely independent and even isolated if it wished to do so, Dr. Feoktistov says that the structure's mass may become a problem and cause for animosity. Technical difficulties and economic cost are underestimated, and Dr. O'Neill's time estimation is too optimistic. Equipment delivery from Earth would be 2-3 times costlier than delivery from the Moon. In the case of material delivery from the Moon, the development of a metallurgical plant, building material industry, et al. on the Moon would be necessary. Methods of material delivery from the Moon are either doubtful from a technical viewpoint or too costly. Humanity must solve problems of nutrition, energy, and population growth on Earth before it has a chance to build space settlements. The creation of space settlements is a realistic and feasible project, but it will take a longer time. Probably, it is more expedient to start with shorter distances such as building a permanent station in a twenty-four hour geostationary orbit or even closer.

THE COSMOS 954 INCIDENT AND INTERNATIONAL SPACE LAW

by ALCESTIS OBERG

Last January, the Russian nuclear-powered spacecraft, Cosmos 954, crashed into the arctic terrain of northern Canada. The incident raised serious legal and diplomatic questions in the international community. Although the fragments of this craft fell on isolated territory and there was no loss of human life, there was potentially dangerous radioactive debris scattered over a large area. In an article entitled "The Cosmos 954 Incident and the Operation of International Space Law" in the January 1979 issue of the *American Bar Association Journal*, two international law experts, the Hon. Edward R. Finch, Jr. and Dr. Amanda Moore concluded that the countries involved—Canada, the U.S. and the U.S.S.R.—handled the incident in a calm and cooperative manner which will serve as a kind of precedent for any future incidents of this nature. Finch is currently chairman of the Aerospace Law Committee, International Law Section of the American Bar Association. Moore is chairman of the Subcommittee on Treaty Interpretation of the Aerospace Law Committee. Their views are, of course, their own and do not necessarily represent the views of the U.S. government, the American Bar Association or any official organization.

In an *L-5 News* interview on Dec. 11, these two law experts stressed the good will involved in the resolution of the difficulties caused by the crash of the Cosmos 954. Prior to the crash, the U.S.S.R. cooperated in efforts to track and to predict the fall of the spacecraft, but predictions of this nature are very difficult.

After the demise of Cosmos 954, the Soviet Union agreed to their liability in this case. Since Canada has a year to fix the exact amount of liability—damage to the land on which the satellite fell, cost of search and recovery missions, etc.—the final amount is not yet known, but is estimated at 12 million dollars, not including the 2.7 million dollars the U.S. contributed by way of nuclear safety teams, sensing equipment and the like. The claim at this time, of course, remains to be settled.

The only area in which the Soviet Union did not cooperate was in giving clear information on the nature of the nuclear reactor aboard the spacecraft.

Also, the U.S.S.R. has not requested the return of the Cosmos 954 fragments, which are still in storage in Canada.

There were two international agreements cited as legal documents in this case. One was the 1972 *Convention on International Liability for Damage Caused by Space Objects*, which states that the country which launched a vehicle would be liable for damage caused by the vehicle's debris; the Convention also makes provisions by which a formal request for damages can be made and so forth. The other legal document is the 1968 *Rescue and Return Agreement*, which states that the launching nation must offer assistance in helping to eliminate possible consequences from the falling fragments of a satellite (in this case, radioactive fragments), and help in evacuation of these fragments. The Soviets offered to assist in the recovery of the Cosmos fragments, but the Canadians declined the offer of help.

> *...the U.S....would be required to notify a foreign power if Skylab is expected to fall within the boundaries of that country,...would be required to assist in recovery operations,... and would be liable for damage caused by the crashing spacecraft.*

Because the device aboard the Cosmos 954 was nuclear, however, serious questions were raised regarding the adequacy of current notification and registration requirements under the 1975 *Convention on the Registration of Objects Launched into Outer Space*. Canada supports a more stringent notification requirement in spacecraft carrying nuclear power devices, but such a suggestion has not been welcomed by the Russians. A Scientific and Technical Subcommittee of the COPUOS (Committee on the Peaceful Use of Outer Space) at the U.N. is studying this and other questions. Should reactors be allowed on spacecraft in low Earth orbit? Should notification be made of impending launches of nuclear-powered spacecraft to the international community? Should radioisotope thermoelectric generators (used by the U.S.) be treated and regulated in a different manner than other nuclear reactors? Should the launching country be required to notify the U.N. of malfunctions on a nuclear-powered spacecraft?

The problems related to nuclear power are being investigated by this Scientific and Technical Subcommittee, which is made up of a working group of experts, including one Soviet representative. The Legal Subcommittee of the COPUOS may consider the legal aspects of this problem under its agenda item "Other Matters". But more concrete measures in the legal area are not expected until 1980.

To date, the need for formal treaty obligations, or for "mandating" coopertion, remains to be seen. The U.S. expressed satisfaction at Soviet cooperation in the Cosmos 954 incident, and the Soviet Union and Canada seem to be making progress toward an amicable settlement in the area of liabilities.

The upshot of the Cosmos 954 incident is that, first of all, it established more fully those procedures by which the problem of debris falling from space onto foreign soil will be handled in the future; and secondly, it may lead to wider reporting requirements of the activities of spacecraft, especially those with nuclear power.

The Cosmos 954 incident may also serve as a precedent for procedures in handling the impending demise of Skylab. The U.S., like the Soviet Union, would be required to notify a foreign power if Skylab is expected to fall within the boundries of that country; the U.S. would be required to assist in recovery operations; and the U.S. would be liable for damage caused by the crashing spacecraft. There are some differences between Skylab and the Cosmos craft: for one, Skylab is not nuclear powered, and secondly, Skylab is about 30 times larger than Cosmos 954.

All in all, Finch and Moore summed up the spirit in which this potentially touchy situation was handled as one of good will and cooperation. So far, the countries involved worked very well on an informal basis, and the upcoming liability settlement will go further in proving or disproving the continued efficacy of international space law.

Thoughts On The Tenth Anniversary Of The First Moon Flight

by JAMES OBERG

Moon flyby by Zond-Soyuz spacecraft, 1968. Several unpiloted tests were made, but Apollo-8 prompted the USSR to cancel a piloted Moon shot.

Ten years ago, Apollo-8 circled the Moon while astronauts sent greetings to Earth and read from the Book of Genesis. Now that the American lunar triumphs have become enshrined in our memories and petrified in our history books, a sense of inevitability and unavoidability clings to these events. They were **bound** to happen, it **had** to turn out that way - or so it looks, now, in hindsight.

A nagging doubt also remains to gnaw at our recollections: what happend, after all, to the Russians? Throughout the 1960s, the thrill of the Moscow-Washington "space race" added spice to our lives. Then we reached the Moon, while from Moscow came only assertions that the Soviets had never really wanted to compete (if they had wanted to, surely they would have won). While a few cynics saw this as a sour grapes reflex, by and large the world accepted the Soviet disclaimers, and in consequence endorsed the theory that greedy politicians and self-serving NASA officials had "tricked" the U.S.A. into a multi-billion dollar one-sided non-race moondoggle.

Thus it was that Walter Cronkite told the nation on the fifth anniversary of the Apollo-11 landing that "it turned out that there had never been a race to the Moon", a judgment that was echoed and re-echoed throughout the West. Few knew that Cronkite's research assistants had concluded that actually there was still dispute over this judgment, and that those specialists most well informed with the Soviet program did indeed feel that the race had been real...but Cronkite or his writers evidently needed to simplify the issue.

Among conservative spokesmen, the happy conclusion that the Russians were incompetent was reinforced by lurid revelations of defectors who claimed that the whole Soviet space program was a "bluff", a Potemkin village in orbit. Lloyd Mallan and other writers in the 1960s tried to prove that Russian space shots were fakes, since everyone knew that Soviet technology was backward if it wasn't pirated from the West.

So Western experts familiar with the intricacies and politics of the Soviet space program have thus observed in dumbfounded amazement how Moscow, unable to write new pages of space history, has successfully set about **re**writing some old pages. In the past, the contents of history books have reflected the opinions of winners in wars, crusades, purges, and other struggles—but not this time. We won the Moon race, and now Moscow's propagandists have written the history!

Let there be no doubt about the facts. To set the record straight, the "Moon race" was totally real. Soviet engineers planned to send cosmonauts to the Moon ahead of American astronauts. Moscow wanted desperately to win the "Moon race" and, with top Kremlin approval and endorsement, poured precious resources of manpower, money, and material into that drive.

The effort faltered and failed, and rather than admit inferiority (which a second place finish would most certainly have done), Moscow cancelled the entire program and swept the abortion under a rug. The program was then publicly repudiated, a propaganda posture which synchronized closely with what many Western critics of the right and the left had been mouthing for years. Apollo was a useless stunt, a wasteful detour, an obscene diversion of resources and attention, a psychotic manifestation of infantile fantasies....

The detailed evidence for this reality has been catalogued elsewhere, in the Library of Congress's *Soviet Space Programs* reports, in *Spaceflight* magazine (particularly the May 1975 issue; published by the British Interplanetary Society in London), in *Space World* magazine (EG, the July 1977 special issue of "Soyuz"), in *La Lutte pour L'espace* (Alain Dupas, Editions du Seuil, Paris, 1977), and elsewhere. That evidence has not been disputed or challenged, but simply ignored.

To summarize it briefly, the Soviets built a one-man translunar variant of the Soyuz spaceship and tested it unpiloted under cover of the "Zond" program in 1967-1968. Cosmonaut Pavel Belyayev privately confided to American astronauts that he had been elected to fly the first mission, scheduled for November 1968 (then, when the first Apollo Moon missions were not expected until mid-1969). Other cosmonauts were in training for an actual Moon landing, anticipated in the 1971 time period. Soviet intelligence reports forecast an American schedule slip of at least two years from 1969. Hardware unique to a piloted lunar landing program was also flight tested, including a Saturn-V sized booster and probably a lunar module (some of the tests remain clouded in secrecy).

The faster-than-expected (by anyone!) Apollo flight sequence, combined with a new NASA administrator's uncharacteristically bold gamble on

Cosmonaut Pavel Belyayer (1926- 1970). With a little bit of luck, he might have been the first person to the Moon.

Apollo-8, scrapped the Zond program which had already been encountering a series of unrelated technical difficulties (but the month of December 1968 was the climax, since a pilot-rated Zond with booster and cosmonaut crew was ready for flight but was delayed for an additional month in anticipation of an Apollo-8 slip). Later, Soviet space shortcomings were underscored by the failure of the booster development program (these problems were accentuated by management difficulties caused by the unexpected death at age 59 of chief Soviet space designer Sergey Korolyov; he was irreplaceable, as the ensuing string of space setbacks showed).

Together with the 1971-1973 Salyut disasters punctuated by the American Skylab triumph, these psychologically devastating events constituted a "sputnik-in-reverse" humiliation in Moscow, only partially alleviated by phony propaganda campaigns. Moscow's reaction (like Washington's to the original sputnik "goosing") was an energetic rebuilding, and we see the results today in 1978.

Meanwhile, the Moon mocks our gullibility in falling for the attempted coverup of Russia's space failure, and for accepting the political neutralization of the implications of the Apollo victory. How can we view our future with any perspective if our past has been counterfeited? Critics have quashed the quintessence of the Apollo triumphs and now sharpen their knives against our new generation of dreams.

INDUSTRY LEERY OF PRODUCTION IN OUTER SPACE

by DAVE DOOLING

A major stumbling block in the way of using space as a resource for producing new materials is getting companies to believe there is potential profit for them, according to a Marshall Space Flight Center engineer.

"Most of the companies we've talked with have very little knowledge of space activities in materials processing," said Richard Brown, director of Marshall's commercial space processing development task team. "The typical comment is 'I can't imagine anything you do in space that relates to my business.' "

And among those who are aware of the space program, the feeling is that it is "an expensive, interesting national hobby."

The processing of materials in space holds the potential, many supporters believe, of becoming a multi-billion dollar industry by the end of the century. Preliminary tests aboard the Skylab space station and Apollo-Soyuz flight indicate that the absence of gravity will make it possible to produce better materials than those made on Earth, or to produce materials that will not form under gravity.

Brown's team is charged with explaining to industries outside the usual aerospace circle what they might be able produce in space, such as new electronics, lenses and drugs.

To date, he said, his team has briefed companies representing 25 percent of the gross national product.

"What we're up to is trying to translate the technology of materials processing into public benefits," he said.

"We make a particular point that materials processing in space is not space colonization, mining of the Moon, mining asteroids or large space factories.

"We are trying to drive the program into a transition phase," with government and industry sharing the risks and rewards, he said.

Such an arrangement, involving money from both sides but no exchange of cash, is not unlike the land grants that made railroad expansion possible in the last century, or subsidies which gave birth to commercial aviation earlier in this century.

"We're not talking about a Sugar-Daddy deal," he said. "We want to negotiate good, sound business."

But before industry accepts that, Brown admitted, there is a need for products that can be made and will sell.

"The number one problem in selling to the industrial community is we do not have identified anything on how to use space that can really stand an economical analysis," he said.

Taking into account all costs, including riding the reusable Space Shuttle, materials produced in space early in the program will cost around $500 per gram, so they must be of very high value.

"The agency does not want to go into space (to process materials) unless it can only be done in space, or done better in space," he said.

Even if he had processing equipment ready to fly, Brown said he could not sell it to anyone until financial, legal and marketing questions are answered.

The task team at Marshall was established to help work those problems out.

"One of the models we studied before doing this is the county agent system," he said, "the most successful technology exchange in this country."

Like county agents, he explained, Marshall acts as an intermediary between two specialized areas of industry, interpreting needs and problems into words the other understands.

Part of the problem the space agency deals with is patent rights.

Under the Space Act of 1958, if a company spends $5 million of its own money developing a new idea, then scores the breakthrough with a $100,000 contract from the government, the federal government owns the whole thing.

Brown said that leasing equipment—as well as a patent-waiver clause—may help eliminate that large block to industrial participation.

Other problems include regulation, which the space agency does not want to do; data protection and Freedom of Information Act; reimbursements; liabilities and antitrust actions.

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NEWS BRIEFS

LATEST SHUTTLE SCHEDULES

Latest Space Shuttle Orbiter 102 schedules, as planned by NASA in early December, called for "roll out" of the first real orbital flight model of the Shuttle from the Palmdale, California plant the last week in February. It will be transported overland to Edwards AFB and then mounted on the back of the 747 carrier aircraft for transportation to Cape Canaveral the first week in March.

Present launch plans are for the first orbital flight to occur September 28-30, 1979. The second flight, formerly assigned to the Skylab re-boost mission, would be launched January 29, 1980.

Originally designated "SS-1" and "SS-2" (for "Space Shuttle"), the flights have been renamed "STS-1" and "STS-2" for "Space Transportation System", avoiding any possible unpleasant connotations associated with the initials "SS". The missions have also been referred to as "OFT-1" and "OFT-2", for "Orbital Flight Test", since six flights are planned before the Space Shuttle enters the "operational" phase of its program. However, the OFT missions as planned and numbered may not be flown in sequential order, so an independent designation was needed.

The final four flights in the test series are slated for May 15, August 1, October 8, and December 1, all in 1980, and the first 'operational' mission, to be used to launch the "Tracking and Data Relay Satellite System", will be "STS-7" on February 27, 1981. The first Spacelab flight is now assigned to STS-10 on July 22, 1981.

CHINESE SPACE STATION BY 1986

BY DAVE DOOLING *

The head of the space agency of the People's Republic of China has said that the Chinese will have a space station in orbit in a few years.

Dr. Edward Ezell, a contract aerospace historian in Woodbridge, Va., wrote recently that Jen Hsin-Min gave him a glimpse of China's plans in March. Ezell also has written the official histories of the Apollo-Soyuz mission and the Viking Mars mission.

According to Ezell, Jen said that China will have a space station by 1986. "They're talking about more than a spacecraft," Ezell said, "but less than a Skylab." Skylab is the U.S. space station used during 1973-74. Ezell said Jen would give no further details.

Jen's promise, though, implies that China soon must start piloted space flight in order to gain experience for such an undertaking.

China already has orbited eight satellites and recovered three. Adding a pilot to a spacecraft should not be too difficult.

It took the United States about a decade to go from the start of project Mercury, a one-person space capsule, to most of the technology that built Skylab. One advantage the Chinese have is free access—through open literature—to much of that technology.

FRENCH SPACE SHUTTLE

by Dave Dooling *

The Centre National d'Etudes Spatiales in France reportedly is studying a piloted hypersonic glider that would be launched by Ariane, a throwaway rocket now under development.

The craft would have a crew of three and would carry a payload of "a few tons." The U.S. shuttle will carry up to 32½ tons, and will also act as a hypersonic glider when it returns from space.

A lobbyist for the European aerospace industry has said that Europe needs an astronaut launch capability independent of the United States.

Ariane is being developed by the European Space Agency—mostly with French funds—to compete against the U.S. for communications satellite launches. A high-energy upper stage would be needed to boost a piloted glider into orbit.

Ariane's payload capacity is also being upgraded from four to six tons to enable it to launch automated laboratories. These would compete with some of the science programs planned for Spacelab, a European-built science workshop that will fly inside the U.S. shuttle.

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Institute For The Social Science Study Of Space

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OBJECTIVES

In recent years, technological concepts have emerged that suggest utilization of the space environment on an unprecedented scale. Numerous scholars and thoughtful citizens have suggested that the rise of the large scale industrialization of space should be accompanied by ongoing assessments of current and projected societal impacts. Spontaneous activity in this area has already occurred, but a serious need is emerging to establish a vehicle to coordinate this research and scholarship.

Consonant with this need, the Institute for the Social Science Study of Space, a non-profit educational and research institute, is being established to facilitate the systematic investigation of the human factors bearing on the development and utilization of space. The Institute's purpose will be to coordinate and mobilize the social science and humanities knowledge and expertise which must accompany technical development of the space environment. In doing so, the Institute will work to provide a more complete understanding of the impact of space development on society, indirectly generating a broader information base for planning future space endeavors.

The Institute will seek to aggregate the resources of all the recognized social science and humanities disciplines. Over an extended period of time, the interaction of these disparate disciplines—focusing on the space environment—will very likely result in the evolution of a new discipline possessing its own internal coherence and methodology.

PROGRAMS

The Institute's strategy is to develop an infrastructure by establishing basic programs used in community-building in the social sciences and humanities. Programs will be established as funding permits. Following are some we plan:

A clearinghouse to handle general and specific inquiries from individuals and institutions interested in learning about this new field of study.

Focused publications, such as regularly issued journals, newsletters, and occasional special studies, are primary instruments for building a new field of study. The Institute would develop these communications channels as a means of improving the quality of discussion, facilitating the exchange of information, and encouraging reflection in the field. In this regard, the first volume of the **Space Humanization Series** is already being assembled. The **Series** is a forum for scholarly articles on space social sciences and humanities.

The Institute is developing a carefully focused library which serves as a centralized reference point for prospective researchers.

Additional programs, including the development of conferences, teaching seminars, workshops, and the offering of academic courses in the field—will be established as resources permit.

FUNDING

The ISSSS has applied for 501(c)(3) tax status. If you are interested in supporting the Institute's work, please send your tax exempt donation to: Institute for the Social Science Study of Space, Suite 403, 2135 Wisconsin Ave. NW, Washington, DC 20057.

SPS Research Topics

Are you looking for a topic for your doctoral thesis? The Universities Space Research Association, a consortium of colleges and universities conducting space research, has identified a wide range of topics in the field of solar power satellites suitable for graduate research.

These topics are detailed in "Report of the Solar Power Satellite Task Group," which was prepared by W. E. Gordon, Dean of Natural Sciences, Rice University; Om Gandhi, Dept. of Engineering, University of Utah; Curtis Johnson, Chairman, Dept. of Bioengineering, University of Utah; L. J. Lanzerotti, Bell Telephone Laboratories; George L. Cisco, Atmospheric Sciences Dept., UCLA; John Zinn, Los Alamos Scientific Laboratory; and Harlan J. Smith, Chairman, Astronomy Dept., University of Texas at Austin.

Copies of the report can be obtained from the L-5 Society. Price is one for $3.00; for additional copies add $1.00 per copy. Send orders to L-5 Society, 1620 N. Park, Tucson, Az. 85719.

Space Settlement Shows

The NASA Technology Application Center at the University of New Mexico has completed a presentation for classroom instruction and public briefing on space colonies.

Space Settlement One illustrates basic concepts and technology of space colonization, including

settlement location at L-5
habitat and life support,
lunar mining and ore transport,
zero-gravity construction,
extraterrestrial agriculture, and
space transportation.

The presentation also considers costs and financing, and especially the value of 24-hour solar energy to large cities on Earth.

The presentation package includes a synchronized cassette tape with narration and original music background, printed script with descriptions of visuals, and a discussion guide with additional information and questions on the topics covered.

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Price is $98; $105.05 with carousel tray. Send your check or purchase order to Audiovisual Institute, 6839 Guadalupe Trail NW, Albuquerque, NM 87107. All overseas shipments must be prepaid.

If you wish to design your own slide show, write for the 74 slide L-5 Society Slide Show catalog, 1620 N. Park, Tucson, AZ, 85719.

Book Reviews

Colony, Ben Bova; Pocket Books/Simon & Schuster/Gulf & Western Corp., 470 pp. 1978.

Colony is the first novel explicitly about the L-5 Community. Earlier novels, such as Pamela Sargent's **Cloned Lives,** have incorporated L-5 colonies but only as a relatively undeveloped, undetailed background. With the colony as his subject, Bova focuses on the broadest issue –the *meaning* of development on the high frontier vis-a-vis the global civilization which has sponsored that development.

Bova has set most of **Colony's** action on Earth; only the opening and closing chapters portray Island One. Colony-born David Adams, a computer freak by nature and a social forecaster by vocation, runs away from Island One on an initiatory quest through the rapidly deteriorating global civilization of 2008. On Earth nuclei of great power, a World Government, a consortum of directors from five multi-national corporate oligopolies, the leader of Latin American and African revolutionaries, and the People's Revolutionary Underground, a worldwide terrorist organization, vie for control of Earth's remaining resources like queens in a four-colored chess game. David enters this game as an unwitting pawn of the multi-nationals and agent of the Colony. He achieves self-discovery, the king row and promotion at his adventure's end.

Colony is much more reminiscent of Erdman's **Crash of '79** than it is of Clarke's space station sketches of the 1950's. Details of colony life are woven into the L-5 chapters, details ranging in diversity from Carolyn Henson's goats to glimpses of a new human-machine interface. These details and their implications are regularly subordinated to, often eclipsed by, Bova's grim attention to the inevitable working out of the Club of Rome scenario. The relationship between the L-5 and the Club of Rome scenarios has received scant attention in print, yet the latter's field of diminishing potentials and increasing limits describes the world in which L-5 will be accomplished. **Colony** is most important for having initiated discussions of this issue.

If **Colony** has a weakness it is the weakness of L-5 speculations in general, namely that the soft technologies of economics, society, polity, and culture have not received consideration equal to the discussions of hard technology and short range politics. A half dozen examples illustrate this.

1. **The Political Context**

Bova posits a planetary government for Earth; the United Nations has disintegrated and a new regime with the power to effect its decisions has been organized. This power derives in largest part from the Lunar City/Colony Selene. Bova chronicled Selene's break to independence and autonomy in his earlier novel **Millenium.** Initially equipped as paired U.S./U.S.S.R. bases, Selene has the position power and the equipment to enforce global disarmament and support the World government.

These developments seem unlikely. Lunar urban development (a city comparable to the one portrayed in **2001: A Space Odyssey**) would be exorbitantly expensive, could probably never achieve self-sufficiency and economic independence from its funding agencies and is not, in light of space-medicine findings, a desirable environment for long term human occupation or settlement. The political role played by Selene could be played by an early Satellite, because for Bova, L-5 and Club of Rome the crucial issue in this respect is the probable conduct of nation-states in the off-planet environment. Nation-states are creatures of territory; they are vitally concerned with the defense, maintenance and expansion of that territory. As a consequence, nation-states are inherently martial. Despite the arguments of **Millenium,** which are largely psychological, it seems likely that orbiting military colonies would not be motivated to support global disarmament at the expense of their national governments.

World Government also runs counter to the global trend of the past two centuries. Settlement of the last terrestrial frontier marked the climax period of nation-states and territorial empires. Since then empires have fragmented and decolonialized into increasingly more local and autonomous political units. The world of 2007 will likely see many smaller states engaged in multiple and shifting mutual-interest alliances as prefigured in O.P.E.C. and the Association of Equatorial Nations.

2. **The Economic Context: Global**

The Eurodollar crisis of 1965 was a key battle in a silent revolution. The multinational corporate oligopolies emerged as "the largest and most inclusive groups that make and implement decisions about the exploitation and allocation of energy potentials in the environment" displacing the nation-states along the leading edge of human adaptation. These new units are stable; for example the pattern of directorate interlocks in the New York oligopoly has remained constant for 20 years, from 1957 to 1977. The MNC's have very different objectives from the nation-states. Planning regularly extends their horizons in both time and space. Predictable markets and sales growth have replaced raw profit as their primary objectives. The MNC's thus have vested interests in global peace and a steadily rising global standard of living. Their interest in territory per se is negligible and they have most to gain from development on the high frontier. The export of major industry into orbit is the natural next step in a sequence which can be traced from Great Britain through the United States to Germany and Japan, then to the newest fourth generation industrializing nations.

Bova suggests a relatively late involvement of the multi-nationals in developing the high frontier; typically the MNC's have used the larger governments to underwrite the high costs of prototype development, committing themselves to projects only after the period of greatest initial research and development expense. Bova seems to favor earlier involvement of the MNC's in L-5 development, yet portrays the directors as crass, gluttonous, selfish robber barons, anarchronisms from the earliest phase of the industrial revolution. This will not attract **their** favorable consideration.

3. **The Economic Context - Local**

The local economy of the Colonies remains virtually ignored in the L-5 literature. Bova suggests a credit card economy - underwritten as today by the corporate Eurodollar? – and only a few colonial exports - the satellite solar power systems, automata in diversity and biological products resulting from safely insultated recombinate-DNA research and experimentation.

The MNC's will always want to own and control their orbiting industrial facilities, but ownership of the residential systems may prove neither feasible nor desirable. Studies of frontier economies and industrial communities argue that company towns stagnate rapidly. The residential system sold by its multinational contractors to the residents collectively would encourage the 'free' exploration of the production possibilities of the orbital environment, and a rich and diverse export economy for the Colony.

The reader can only infer from **Colony** that information may be one of L-5's most valued exports. For example, the construction and management of the complex Colonial ecologies – both industrial and biological – may generate the theories and techniques for the rehabilitation of Earth's battered native systems.

4. **Information**

One of **Colony's** brief but most exciting speculations is a new man-machine interface. David Adams has grown up with a micro-terminal implant; he has learned to use the Colony computer as naturally as a bicycle. But on Earth, deprived of access to that tool, David feels naked, incomplete. However, Bova does not recognize LOGLAN as the language appropriate to the man-machine interface and as a lingua franca for a polyglot human population in a high stress environment.

5. **Energy**

Energy is what it's all about for **Colony**, The Club of Rome and the L-5 scenarios. The capture and control of that energy is the human adaptive challenge for the closing years of the 20th century. Bova warns that the Colony, at the center of the SSPS network, could easily become more tyrannical in its control of energy than any nation-state or multi-national corporation yet recorded. This is not an encouraging speculation, but it is realistic. The soft technologies which will govern the resources of **Colony** must be as rigorously and humanely pre-thought as the hard technologies which will deliver that energy.

6. **Characters**

In addition to David Adams and the corporate directors, two characters deserve special mention. Appearing only briefly in the early chapters, an architect has been commissioned to rebuild the Hanging Gardens of Babylon. The pointless expense of this undertaking succinctly illustrates the decadence which will likely accompany the earlier phases of the Club of Rome scenario. In sharp contrast, David's social father, the senior administrator of Island One, Dr. Cobb, emerges almost as a deus ex machina. Cobb was employed in this position by the corporate directors because, as an applied anthropologist, he was a jack of all social science trades. Much of the happy ending seems to trace to his deft manipulation of the Colony system: Social scientists take heart!

Colony is worth reading. Its real value will be measured by the counter-speculations it provokes in both the fiction and non-fiction realms.

Reed D. Riner
Assistant Professor
of Anthropology
Northern Arizona University

Letters

The L-5 Society needs to become much more vocal in Washington, D.C. because of Carter's recent announcement rejecting "spectacular" space missions. Let's group together and support a presidential candidate in 1980 who will at least attempt to support the colonization and industrialization of space. Also, with the current interest in space so prevalent among the younger people in this nation, it becomes imperative to keep that interest kindled so that the majority of voters in 10 years will support the L-5 Society's goals. I hopefully intend to continue my membership until space colonization is achieved.

Barbara A. Mackinder
Denver, Colo.

Let's stop using the misnomer 'artificial gravity' to refer to the forces used in spinning toroid or cylinder structures, forces which simulate gravity and give a sort of ersatz or *pseudo*-gravity. Of course it is not gravity, it is inertia, and it is not physically correct to call it gravity, no more than it would be correct to say that astronauts blasting off experience a gravity field three times as strong as on earth.

So here's my proposed term: PSEUDO-GRAVITY. It is left to the reader to devise six ways by which an experimenter in a sealed room could easily differentiate between spin pseudo-gravity and mass-induced planetary gravity.

Why be picky? Because in a decade or a century or a millenium, we will be able to produce appropriately named 'artificial gravity,' by manipulating the fabric of space/time with tricks undreamed of today. A dozen Nobel prizes are waiting. The application of energy and cleverness will allow humans to turn on and off gravity fields or whatever level they desire—and *that* is what should be termed 'artificial gravity.' So *save* the terminology for what deserves it, and be satisfied—as we shall be for a few decades or centuries—with space-based PSEUDO-GRAVITY.

IF we need it at all. Bill Thornton, a NASA astronaut-physician, stressed to me the other day that 'calcium loss' is not a universal physiological effect but hits less than half the population, and it can be predicted pre-launch. Further, everything else in weightless adaptation levels off, plateaus, so perhaps calcium loss will too. And vertical stress of at most two hours a day counteracts most if not all calcium loss. So MAYBE artificial (oops, I mean pseudo-) gravity is not even a prerequisite for space habitats. If it is, Edward Gilfillan suggests, "Why, so what? Accept the price of a one-way ticket—you'll still get volunteers who don't care that they never will have to return to Earth, never can return to earth."

So much for my comments of/on gravity.

James Oberg
Houston, TX

An important stage in the growth of the idea of solar power satellites and space colony development is the use of these themes in major science fiction novels. For one thing, science-fiction fandom is large and organized, but a surprising proportion is amazingly unaware of the real-world possibilities of space development. For another, the novelists, for purposes of dramatic interest, have focused on the potential of SPS and space colony development for personal tragedy and global disaster. That makes them required reading for SPS/colony proponents, since we may tend to forget that they may not come into being as benignly as O'Neill suggests.

All three of the major novels published to date—Terry Pournelle's *High Justice*, Ben Bova's *Colony*, and *Skyfall* by Harry Harrison—convey their authors' conviction that SPS/colony development is a logical and desirable goal, while depicting in harrowing detail what may happen if that goal is pursued in a venal, short-sighted or malicious way. Human nature being what it is, that is perfectly possible; and like it or not, any highly concentrated, highly centralized energy system—like SPS, breeder reactors, or thermonuclear fusion—has the potential for catastrophic mismanagement to balance its potential for human good. An SPS system may be less prone to bungling, but it cannot be made immune from it. (That helps to explain why anti-nuclear forces have not, by and large, become pro-SPS—they're basically pro-decentralization, and to the, an SPS is just more of the same old thing). Harrison's *Skyfall*, showing what political expediency, pettiness, and general stupidity could do to a joint Soviet-American SPS launch, is a good example.

In any case, anyone interested in space development could read any of the three stories for pure entertainment—they're excellent novels by first-rank writers— apart from their thought-provoking value for anyone with a stake in our future in space. If that's where we want to go, we must do it with both eyes open for human pitfalls as well as technological ones.

Peter H. Shaw
Albuquerque, New Mexico

Thank you for the very interesting article (Nov. '78 *L-5 News*) giving the several sides to various aspects of the SPS concept. I have several comments pertaining to various statements in the article.

Mark Gibson is incorrect in his 2500 km^2 estimate of the area required for the 10 GW rectenna. The 5 GW rectenna proposed by NASA would be an oval 10 km X 13 whose area would be about 103 km^2. Adding a restricted public access strip 1.28 km wide along the perimeter to reduce the microwave radiation level to 100 microwatts/cm^2 brings the total area to about 150 km^2 or about 37,000 acres. This is comparable to the Dallas-Fort Worth airport (based on my estimate of the DFW land area). For comparison, using a surface collector solar system to power Dallas would require a land collecting area approximately 10 times the area of that city.

A computer study conducted by Jim Blackburn of Rice University has concluded, after examining the entire U.S., and applying certain exclusion variables, that the SPS concept should not be ruled out on the basis of the contiguous land area necessary for rectenna siting.

Mr. Gibson criticizes the variability of rectenna cost estimates between the Johnson Space Center and Marshall Space Flight Center designs as evidence that the cost estimates are not trustworthy. In fact, the JSC and MSFC rectenna designs are very different. The JSC concept calls for individual discrete dipole rods whereas the MSFC concept at the time of the cost data referred to by Mr. Gibson was a so-called stripline multilayer printed circuit board, probably far cheaper to manufacture and erect. Rather than criticizing such design variability, it should be encouraged.

I question the authenticity of Mr. Gibson's statement, which he attributes to NASA, that to be competitive with terrestrial systems, the SPS must meet all projected electricity demands by 2025 using a 112 satellite fleet deployed in 30 years. At one time, NASA did, for calculational purposes, entertain a 112 satellite fleet scenario. This was for the purpose of flushing out resource limitation problems. However, the present NASA baseline scenario calls for one 10 GW or two 5 GW satellites to be built per year. The SPS is still expected to be economically competitive at this pace. Economic competitiveness is not determined by such parameters as demand supplied. Rather it is determined by such parameters as cost/kw of installed power and the cost of resulting electricity, etcetera.

Mr. DeLoss criticizes previous SPS cost estimates as having been made by those interested in seeing the SPS fly. Rice University has a privately funded program whose goal is to "objectively" evaluate the practicality and feasibility of the SPS concept. Aware of the criticality of cost to ultimate SPS acceptability, and to criticisms of the type put forth by Mr. DeLoss, we attempted our own modest SPS cost estimate with the help of a consultant, Mr. Paul Purser. Using rather different costing techniques, principally extrapolation of historical unit cost data for the U.S. and U.S.S.R. space programs and the size exponent and learning curve methods we established that the NASA estimates are consistent with the estimates obtained by these other techniques.

One area that your article did not deal with is the SPS evaluation program being undertaken by the Department of Energy. I am very pleased with the planned scope and thoroughness of this program. It is important that we examine as completely as possible the ramifications of all new technologies before they are deployed. We will not be able to have all of the answers before we plunge ahead on SPS. However, the very existence of this rational examination of the SPS technology may be the signal of a new maturity in man's collective intelligence. There is a burden on all of us to look at things analytically and not emotionally. The SPS concept does indeed face serious problems, not the least of which are emotional public reaction and premature judgment.

John W. Freeman
Professor of Space Physics and Astronomy and Director, Space Solar Power Research Program
Houston, Texas

On October 4, 1978, the twenty-first anniversary of the Sputnik launch, the USC L-5 Society, at the University of Southern California, held its founding meeting. Although it is hoped that UCLA will establish an L-5 chapter, the listing in the October *L-5 News* was incorrect. We are USC, not UCLA, and perhaps you could note the error. The two schools are intense rivals. The USC L-5 chapter has numerous plans for activities on campus, including a week of space films, speakers, a bookstore display, and the establishment of a USC L-5 library of books, films, slides, etc. We deeply appreciate your assistance in establishing the club, and hope to contribute to the overall L-5 growth, especially in terms of international development for the society.

John A. Blanton
President, USC L-5 Society

My thanks to Gordon Woodcock for his concept of the energy market as having several segments (*L-5 News*, Nov. 1978, page 9). He has clarified some ideas which I have had for a long time:

There are three major segments to the energy market: heating & cooling, electrical appliances (ranging from table radios to the giant aluminum-producing crucibles), and transportation. Intrinsically, there is no reason why any two segments should be served by the same fuel/system, except for the current state of technology.

Two hundred yearrs ago the three segments were supplied by wood, coal & water power (for machinery), and grass (for horses). Today, the segments are supplied by oil, oil & coal & uranium, and oil.

At the current state of technology and energy transport systems, SPS will only supply the second segment, electrical use. Distributed-solar enthusiasts should be assured that they can have segment one, heating & cooling, all to themselves, and that segment three, transportation, is being left alone for gradual, undirected change.

Howard G. Beatman
New London, Conn.

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1 **Space Problems Examined at National AAAS Convention**
L-5's Alcestis Oberg covers the symposium in Houston.

2 **Who Will Go? Selection Procedures for Future Space Colonists**

3 **No Green Thumb Necessary in Space**

4 **Overview of Closed Life Support Systems**
As the Stomach Turns

5 **Economic Forecast for Space Projects Gloomy**

6 **Standing Room Only**

7 **Space Design for Safety**

8 **Developing Hardware to Support Life on Long-Term Space Missions**

9 **Space Processing: A New Study Begins** *By Mark Hopkins. Can the production of materials in outer space pay off?*

10 **New Space Legislation** *Ken McCormick summarizes the latest on space in Congress.*

AIAA & SPS *by Ken McCormick*

11 **Space Day in New Orleans** *by Chuck Landau*

12 **News Briefs**

Armed Guards Posted Around Shuttle
NASA's 1980 Budget
European Moon Probe
U.S. to Help China
New Astronaut Selection
Space Manufacturing Conference *Register now!*

14 **16th Space Congress Proclaims: Space — Everyone Benefits**
This annual symposium is coming to Florida in April.

Inside the L-5 Society

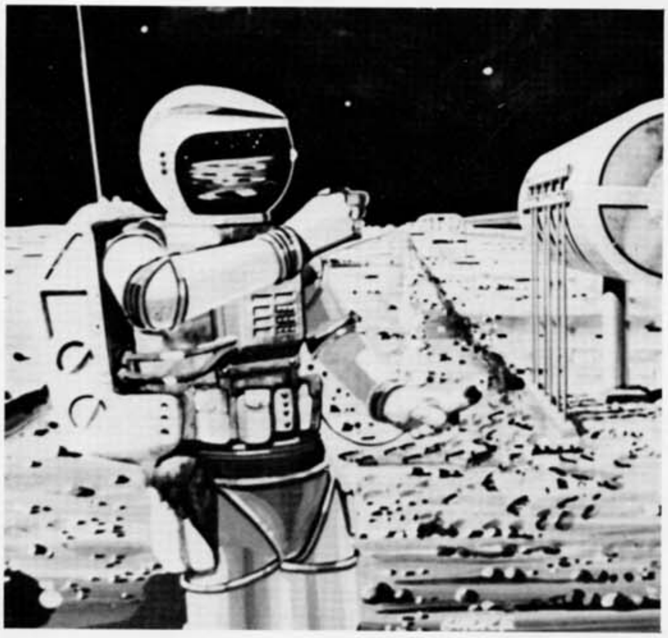
Ohio L-5 Chapter Starting

How to Create an L-5 Chapter *Carolyn Henson gives the step-by-step procedures.*

15 **Bylaws Election** *It's up to you to ratify the new Bylaws amendments. Included in this issue are the proposed amendments, complete L-5 Society Bylaws, and a postcard for voting.*

COVER: Looking to space for the future of humankind.

Space Problems Examined at National AAAS Convention



Scientists explored the "Human Factors of Outer Space Productions" and recognized "Agricultural Systems for Space Habitats."

By ALCESTIS R. OBERG

EDITOR'S NOTE: Many thanks to the members of the L-5 Society who helped cover this convention. Special thanks to Margaret Adamson, Mike Nichols, Mike Pelizzari and Leo and Freny Berkenbile for rendering aid and comfort above and beyond the call of duty.

Our special congratulations go to Stephen Cheston and David Winter for arranging such a fine session on the "Human Factors of Outer Space Production." The same goes for the well-done session on "Agricultural Systems for Space Habitats" arranged by Jack Spurlock and Micheal Modell.

Houston weather was at its dismal worst for the AAAS (American Association for the Advancement of Science) National Convention January 3-8. Thunder, lightning, heavy rain, cold and fog simultaneously greeted L-5ers who attended the Saturday sessions on "Human Factors of Outer Space Production" and on "Agricultural Systems for Space Habitats."

And there were other inauspicious omens. All the hotel flags at the old Shamrock Hilton were at half mast, for the fallen Conrad Hilton. Conrad's portrait draped in black greeted all elevator-users. And to make matters worse, the Shamrock's Emerald Room, in which the "Human Factors" talk took place, was a chilling 58 degrees, simulating what life will be like in the energy-poor '80s. The stout-hearted L-5ers who attended it huddled together for warmth. One L-5er muttered, between chattering teeth, "It's as cold as Proxmire's heart."

The papers, however, were warm with enthusiasm. They dealt with such exciting subjects as farming in space, different designs and safety features for large structures in space, problems with the human body in conditions of weightlessness, testing methods for screening potential space colony inhabitants, and so on. It was as fascinating as reading a good science fiction novel — better, in fact, since these scientists were dealing with existing possibilities.

But the optimism and hope for the future in these papers were not reflected by the economists who attended these meetings or by the journalists who gathered in the lobby and in the restaurant of the hotel. There, conversations were dominated by concern for the very existence of NASA.

Economists at this convention have offered many feasible and practical suggestions on a number of key issues, such as financing high-cost energy projects and looking into the financial potential of materials processing in space. But in private conversation these economists confided that the Carter Administration showed no interest in selling or developing the potentials of space, either in the area of solar power or in space manufacture. Others indicated that their suggestions for even the most minor policy changes in order to stimulate interest in these areas have fallen on deaf ears. And the overall impression was that Carter preferred austerity on Earth to the risks and opportunities of space industrialization in the future.

Even more disconcerting was the rumor, affirmed from many different sources here, that the Administration was planning to take away NASA's autonomous status entirely by attaching it to the Department of Transportation.

While a gathering of journalists pondered the myopia of Carter's space policy in the hotel restaurant, the "new austerity" was underscored by rain which dripped relentlessly from a faulty ceiling, drafts which assaulted the diner from all corners of the room, the absence of butter in a lukewarm buttered rum, and a meal that was cold — stone cold.

"We can do better than this," one person said, thinking perhaps of the 1980 elections, as he watched the sauce on his duck congeal before his eyes.

Who Will Go?

Selection Procedures for Future Space Colonists

"We don't want risk-takers who see danger as a kind of cleansing by fire!" exclaimed Dr. Kirmach Natani from the Department of Psychiatry, University of Oklahoma Health Science Center. In this talk on assessing candidates for jobs in space, he said he hoped this type of individual might be screened out in a selection procedeure that would combine psychological and neurological information. neurological information.

Survivability, social adaptability, high performance in stressed circumstances and innate cautiousness would be desirable qualities in space colony candidates, in addition to expertise in a given field, he said.

Psychological evaluation is often done now by means of psychometric measurements which involve interviewing a candidate and asking this person how he or she feels about various things. Also, socio-cultural background, intelligence and physical well-being are taken into consideration. "But the weakness in this kind of evaluation is that it assumes the individual knows how he feels and is honest about his feelings," Natani said.

A neurometric assessment, on the other hand, tests the nervous system of the candidate and provides a different kind of data. The equipment required for this is a desk microprocessor, flow charts of procedures for testing tasks and responses, and a strange-looking testing apparatus in which the candidate sits in a deliberately uncomfortable hunched position as his or her physiological responses are tested. As the candidate's responses to novel situations and tasks are tested, the physiological data is fed to the computer which compiles and analyses this information immediately, on a specific response-by-response basis. Since the test situations arise suddenly, the candidate does not have time to deliberate but must respond quickly. In this way, the individual's unconscious, nonverbal, innate responses to novel situations can be assessed.

The weakness of this method is that it favors individuals who do well at visual tasks and perform well in a hunched position. "This could be overcome by giving a battery of tasks in a variety of positions," Natani said.

A neurometric assessment provides much valuable information about the nervous system of an individual. Such an assessment may help future personnel administrators weed out those who are accident prone and those who become negligent and careless when bored. Also a candidate may be counseled in areas of weakness and can be given specific reasons for non-selection. When psychometric and neurometric assessments are combined, a fairly competent and precise evaluation of a candidate can be made. This will aid those who must select and reject candidates for jobs in space.

Because a space habitat is a hazardous environment, thoughtless and reckless behavior on the part of one person may endanger the whole habitat. "It doesn't hurt to choose someone who is somewhat paranoid, that is to say, one who continually takes into account the potential hazards of one's environment," Natani said. And since novel situations are bound to arise in space habitats, it is important to assess and to predict a candidate's behavior ahead of time.

"In the past, astronauts came from stressed backgrounds; they were used to stress and novelty. But now people applying for jobs in space come from unstressed backgrounds; they are not test pilots. Neurometric assessments of these people can play an important role in the screening procedure," Natani claimed.

The clumsy of the world need not despair, though. Once the hazards of space life are reduced, they too could be chosen as space colonists, Natani assured the audience.

No Green Thumb Necessary in Space

CLSS Will Be Run By Computer

Plastic greenhouses in current use can provide experience and research for future closed life support systems.

"You don't have to be a farmer to grow food in space," said John Phillips of Arizona Research Associates, Inc., Tucson, Arizona. In his presentation entitled "Developing Controlled-Environment Agricultural Systems for Large Space Habitats" (co-authored by Annita Harlan of Pima Community College and Carl Hodges of the University of Arizona), Phillips claimed that agricultural systems in space would be monitored by computers which could regulate nutrients, moisture and other such things.

Much research must be done, of course, before such a reliable, safe closed life support system (CLSS) can be developed for a large space habitat. Diet scenarios must be drawn up to meet the needs of the crew, crop species must be chosen for such a system, various animals must be studied for suitability and the system must be very reliable, predictable and labor efficient. Also, the environment of space must be studied in order to assess its influence on biological components.

However, the controlled-environment agricultural systems (CEA), currently under development and expansion in the U.S., Japan and elsewhere, can provide a good data base of experience and research for CLSS. The use of greenhouses to raise tomatoes in the winter is an example of CEA. Japan, a country with little arable land, uses CEA to a larger extent than the U.S. "Some farmers erect low-cost plastic greenhouses on rice land during the fallow winter season for the production of melons," Phillips said. There are enormous benefits in CEA: very large and predictable yields, and independence from such troublesome factors as poor climate and variable weather. "In the Soviet Union, unfavorable climate is the primary motivator for the production of arbor and tree crops in greenhouses," Phillips said.

But the negative aspects of CEA systems are that they are capital, labor and material resource intensive, he added. And unfavorable economics has been the main reason why cereal grains and legumes have not been produced on a large commercial scale. Nonetheless, a new ice age or contamination of world food supplies by pesticides and other toxins could make CEA systems more viable in the future.

Rice grown in a controlled environment.

"Long-term study on the CLSS should also be started," Phillips asserted. Besides use on large space habitats, such an agricultural system can have several applications here on Earth. Already CEA systems are contributing to the food supplies in very congested areas, like Europe and Japan. In a CLSS in which everything is recycled, the inner cities could benefit greatly: "Here there is the space and the need to try new technology for relatively small areas where resources of all kinds have been depleted to the point where a comfortable life cannot be maintained," Phillips said.

He concluded that: "Space is a big enough dream, but it must be made accessible to the individual. Space research concerned with food production touches on a subject that is within the common experience of every person in a society. Research on controlled-environment food production systems for large space habitats may do much to rekindle society's interest and support for space research in general, as food is a subject with which everyone is familiar. A renewed interest in space and the future possibilities for the human race could do much to promote a more positive attitude on the part of individuals in a society that has grown to regard the future with uncertainty, and even with a sense of hopelessness."

Closed Life Support Systems

It is difficult to predict just how a closed life support system (CLSS) will work on a space habitat. "But it is possible to design a CLSS on paper and to predict certain problems," said Dr. Michael Modell, Professor of Chemical Engineering at M.I.T. In his presentation, co-authored by Dr. Jack Spurlock of Georgia Institute of Technology, he said there are certain factors which must be determined before an overall design can be accomplished.

Along with oxygen and water, food is an important factor, the driver in a CLSS. Once diet provides us with the "input requirements" of the habitat (i.e. what animal and plant food will be necessary to sustain life in space), then the method of designing a system is fairly clear. The next consideration would be food preparation and processing, along with the equipment necessary to it. And diet and processing together will determine waste. The processing of the waste will require equipment also. Finally, the stability and the control requirements of the total system are taken into consideration.

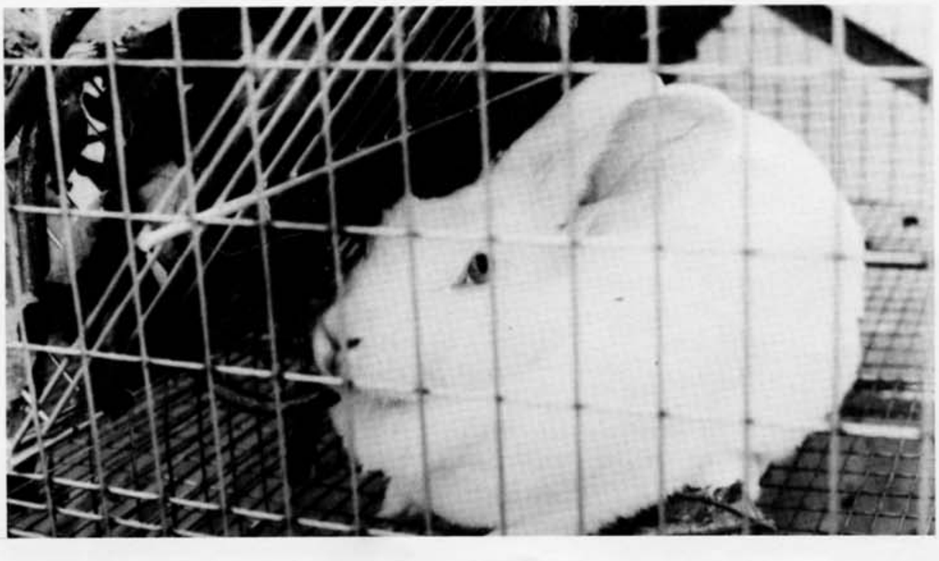
For instance, will the diet options on a space colony be Earth-like, providing large varieties of food? Or will they be very simple, providing only a few kinds of foods? Or will the diet be very unconventional, made of synthetic foods? Such input will determine whether the waste will be processed biologically, chemically, and so on.

Waste processing will be crucial since processed wastes will be recycled back into the food chain. For example, liquid waste from both animals and humans can be recycled by a sophisticated method of filtration and reverse osmosis. Solid wastes can be incinerated, the result of which would be carbon dioxide and ash. Ash contains many minerals essential to plant growth, and could be reintroduced into the food chain by being used as a nutrient for plants.

"Water used for washing is easy to recycle," Modell added, "and could be kept separate from other liquid wastes, since the purification of washing water is not as involved as it is for liquid waste." Such domestic water accounts for 80 % of water used in space.

Of course, the cost of a CLSS must be determined by the size of the crew and the length of the mission. The longer a group of people must stay in space, the more feasible it is to have a CLSS, since it is costly to lift essentials such as water and food into space. The cost of a CLSS will probably be assessed in terms of how much the CLSS equipment weighs, how much power it will require in space and how efficient it is in terms of providing the essentials of food, oxygen and water.

Naturally, much experimentation must be done on Earth which will help a great deal in developing the recycling systems needed in space. But in space, there will be many unknowns: the long-term effect of restricted diets, problems arising from the possible lack of some nutrient, yet undiscovered, and substances that may become toxic in a CLSS. "Another factor is our innate fear of the unknown," Modell said. "But that hasn't stopped us yet."



Bunnies in space? A possible food source.

As the Stomach Turns

Banqueting probably will not be an activity familiar to space colonists of the near future, unless, of course, they favor powdered substances converted into gelatins, agar-agar, synthetic polymer compounds and formula-diet foods. In a presentation entitled "Physiological Criteria for Closed-Loop Space Food Systems," Dr. Paul Rambaut (whose paper was co-authored with Frank Samonski) from the Office of Life Sciences at the Johnson Space Center claimed that human taste is a peculiar commodity, a composite of sensory properties (flavor, texture, odor, sight, sound and temperature), psychological conditioning and internal chemistry. Looking at the subject of food with the eye of a scientist rather than the palate of a gourmet, he challenged the prevalent belief that "humans require a diet of great variety." He said: "Experimental evidence from many sources shows that individuals can be kept on a single nutrient source for many months without suffering ill effects. It is possible to furnish active people with a formula diet with no adverse physical effect or any measurable change in psychological state."

Rambaut believes that plants lead now as a potential source of space food by virtue of their familiarity, but that synthetic foods, stored nutrients and micro-organisms also have possibilities as food sources. Synthetic foods especially could be given desirable tastes and odor with special food additives and special processing, while fulfilling human nutritional needs at the same time.

The nutritional needs of the human body in space are still not well known. Before Skylab, it was believed that human nutritional needs in space were similar to those on Earth. It is now known that certain nutrients are lost during space flight, especially calcium.

"Examination reveals that calcium is lost exponentially as a function of time in flight. Whereas an average of 50 mg per day is lost on the 10th day, an average of 300 mg is lost on the 84th day. An average of 25 g of calcium was lost from the body during the 84-day flight. Assuming a total body calcium content of about 1 kg, the pool is diminished by approximately 2.5 percent.

"When fecal and urinary losses of calcium are plotted independently, two kinetically different processes become evident. Urinary calcium rises rapidly following launch and within 30 days achieves a level approximately 100 percent above baseline. It remains at this level for the remainder of the flight. Fecal calcium, on the other hand, does not begin to rise for two or three weeks following launch. Once fecal calcium has begun to increase, it does so at a constant rate for the remainder of the flight.

"Apparently calcium is being mobilized from the bones. At about the same time this mobilization of bone mineral is occurring, less and less calcium is being absorbed from the gastrointestinal tract. Although normally sufficient quantities of vitamin D_2 were being ingested, it is possible that a deficiency was being developed in the conversion of vitamin D_2 to D_1. This will be investigated further on Spacelab 2.

"Therefore, alleviation of the stress of weight-bearing seems to have a significant influence on skeletal metabolism. During the Cosmos satellite series, investigators noted a complete cessation of bone growth in experimental rats during flight.

"The chain of events leading ultimately to bone loss in flight remains elusive. Several ways of ameliorating the bone losses have been studied on the ground. Protocols involving exercise, compressional suits, lower body negative pressure, and thyrocalcitonin administration have had little effect in moderating the losses induced by prolonged recumbency. Changes in dietary intake, particularly reductions in protein and elevated intakes of diphosphonates, calcium and phosphorus, are promising and point the way to the manipulation of nutritional intake as an important means of counteracting the adverse effects of prolonged weightlessness."

The minimum and maximum limits of other types of foods are still being ascertained. The role fats, carbohydrates and protein will play in future space diet scenarios is not well known. And what form these nutrients will take is another problem. For example, for proper absorption of protein, the protein must be digestible; digestibility varies among proteins, with plant proteins being somewhat less digestible than animal proteins. Digestibility of plant proteins can be improved by refining and by mild heating, but care must be taken not to use intense heat or digestibility will be damaged and some protein lost in the feces.

While needs for various vitamins and minerals are still being assessed, it is easy to take them in supplemental form. The minimum and maximum limits for some nutrients such as various amino acids, are still not well known for Earth-dwellers, much less for astronauts. "There is, as yet, no evidence for alterations in amino acid metabolism inflight. The basis for the use of methionine, asparagine and glutamic acid supplements by USSR crews in this regard is puzzling," Rambaut said.

He concluded that: "It is probable that certain deteriorative or adaptive processes accompanying space flight can affect nutritional requirements in such a way that intakes which are appropriate under ground-based conditions are suboptimal inflight. In closed systems, there exists an added danger regarding toxicity of high levels of nutrient elements. There is often a narrow tolerance between minimum requirement and toxicity, as in the case of vitamin D. A better grasp of requirements and tolerances, and an efficient monitoring system for metals such as copper, chromium, zinc, and cobalt, will be required."

And what is Dr. Rambaut's view of the final form of space food? "Probably the ideal space food lies somewhere between a simple formula diet and a diet of extravagant variety."

Economic Forecast for Space Projects Gloomy

"The SSPS (Solar Satellite Power System) will not be implemented for at least some 20 years," said Bernard P. Miller, vice president of ECON, Inc., of Princeton, New Jersey, in his talk on the economic factors of outer space production. But he added: "Even though the expense of the SSPS cannot be justified now, it is important to keep this option open for the future."

The future of space materials processing looks almost as bleak. Citing the pessimistic conclusions of the National Academy of Sciences study, Miller called for the establishment of a national space laboratory for materials processing experiments, in order to study more fully the possibilities of space manufacturing. But there are knotty problems involved in establishing such a facility. What will be the construction cost of the laboratory? What will be the charge to users of the facility? Could the laboratory be funded exclusively by the private sector? What would be the policy on patents for joint endeavors between NASA and industry?

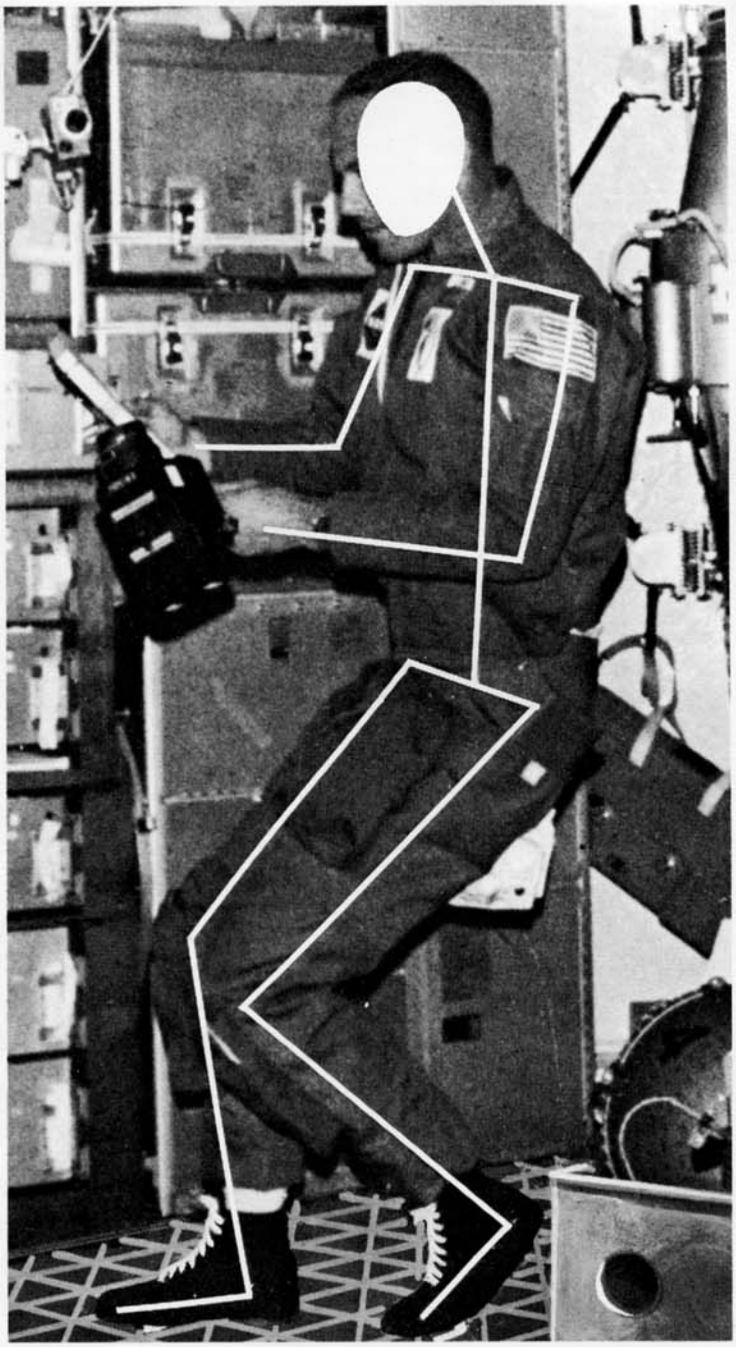
In the meantime, the areas of space technology most likely to receive funding in the near future would be in the areas of Earth observation (with the new LANDSAT due to be launched in 1981) and communications; benefits in both these areas are already well known.

In communications, remote rural communities could benefit from satellite delivery of social service broadcasts in such fields as medicine and education. ECON, Inc. recently studied the feasibility of satellite-aided emergency medical services. Paramedics in remote areas could transmit data to physicians in metropolitan areas via satellite and could render immediate aid to trauma victims. ECON, Inc. estimated that 59,000 lives per year could be saved in this manner in the non-metropolitan regions of the United States if such an emergency medical communications system existed. "The economic benefit of this reduction in mortality would be approximately $2 billion a year," Miller said. The conclusion of the study was that such a system would definitely be cost effective.

Miller also encouraged the participation of private industry in space transportation, claiming that a government monopoly in this area is not desirable and will probably inhibit private investment in space in the future. The Shuttle, he said, is expected to rank 223rd in the top 500 U.S. corporations in the next decade; among U.S. airlines it would rank 7th, right below Delta and right above Northwestern. Private industry would probably wish to participate in space transportation, perhaps by owning and servicing the spacecraft while NASA maintained its control of launch and landing facilities.

Miller concluded by saying that current government policies inhibit private investment in space production. "The lack of entrepreneurship is probably the weakest link in the United States space program today," he said.

Standing Room Only



"In the Shuttle, chairs and seats are only provided for those portions of the missions such as launch, reentry, and orbital maneuvers," said Allen Louviere, Chief of Spacecraft Design at the Johnson Space Center. In his presentation entitled "Man and Machine Design for Space Flight," Louviere said that seating apparatus is quite unnecessary, since the human body takes on a comfortable semi-crouched posture in a weightless environment, very different from the upright posture that it takes on earth. Shoes with suction cups on the bottom will provide sufficient anchorage (otherwise the body would float) while also allowing an astronaut a certain comfort and ease of movement.

Louviere said many factors must be taken into consideration in designing a spacecraft for comfort and maximum utility. The size and volume of the spacecraft must allow for the various functions that the craft will perform. Crew size and mission duration are the two biggest considerations in volume allotment; Skylab with its "somewhat sumptuous" 10,000 cubic feet allowed for many varied functions.

"There are other more subtle things to consider too," he said. On the Earth's surface we take certain activities for granted: digging into pockets for change, showering with soap and water, sleeping in a horizontal position. But in weightlessness even the most commonplace activities can pose problems. Skylab crewmen's garments had circular pockets "to prevent articles from migrating into corners." A special shower nozzle was installed to help wash off soap, since soap clings tenaciously to the body in weightlessness. Electric shavers were designed so that clippings could be immediately vacuumed up. And since there is no up and down in space, sleeping compartments were not horizontal; in fact, the astronauts slept in sleeping bags tied to the wall.

In the Shuttle-Spacelab missions, the arrangement of the workstations is of primary importance. Two significant factors dominate the design of these workstations: change in body posture and the requirement to restrain a crewman in place (with shoes equipped with suction cups in this case). The workstations must also be designed to accomodate a variety of body sizes, since variations in the sizes among the international crewmembers, both male and female, will certainly be a factor. Skylab astronauts ranged in height from 66 inches to 72 inches. But in the Shuttle-Spacelab missions, the height range will be significantly greater, from 61 inches to 76 inches.

"Though subtle to outward appearance, these newly derived standards will greatly facilitate the crewmember's task in the weightless environment," Louviere concluded.

Above: Neutral body position.
Below: Suction cups on shoes, a weightless environment crew restraint.

Space Design for Safety

Safety was emphasized in Richard Kline's talk on space habitat design. Kline is deputy director of NASA Advanced Programs at Grumman Aerospace Corporation. "Now that the Shuttle will make space operations routine, thought must be given to the next step in space development: building habitats in which people may remain in space on a more permanent basis," he said.

Kline envisioned two types of space habitats: one in low Earth orbit (LEO) and one in geosynchronous orbit (GEO). He also saw a need for an orbital transfer vehicle (OTV) to transport people between LEO and GEO.

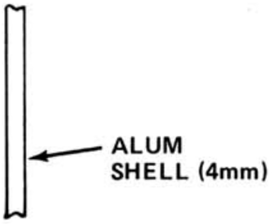
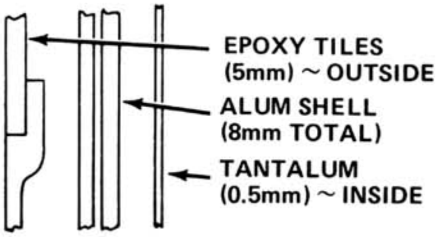
The design for LEO differs substantially from that of GEO. LEO requires only a 4 mm thick aluminum shell, whereas GEO requires a three-layered shell made up of epoxy tiles on the outside (5 mm thick), an aluminum layer in the middle (8 mm thick) and a tantalum layer on the inside (0.5 mm thick). The thicker wall in GEO is necessary for radiation protection, but it causes GEO to be a good deal heavier, and subsequently much more expensive to build. Because radiation levels are so high in geosynchronous orbit, GEO must also have high reliability equipment and built-in redundancy; in-flight repairs by way of EVA (extra-vehicular activity) would be very dangerous. The cost of this equipment would also add substantially to the cost of building GEO.

Solar flares constitute another danger to GEO inhabitants, something that would not be a concern to LEO inhabitants who are protected from radiation by the Earth's magnetic field. In case of a solar flare, GEO inhabitants could get into the OTV and drop to LEO. Or a special storm shelter could be built right on GEO, with an aluminum shell 150 mm thick. The shelter would be small, just enough to accomodate the crew, but would make evacuation unnecessary.

Severe crew illness, accident or failure of a vital system could occur which would require rescue. The cheapest rescue alternative would be to return the crew to LEO in the OTV and wait for a Shuttle to come up from Earth, rendezvous and dock at LEO, and then return to Earth. This would take approximately 120 hours.

But in case of severe illness, this time lapse is too long. Another possibility is using the "lifeboat technique." The "lifeboat" would be a vehicle capable of returning to Earth from space. It would be docked at LEO. In an emergency, the GEO crew could return to LEO and then return to Earth directly from there in the lifeboat, without having to wait for a Shuttle. This "lifeboat technique" would reduce the rescue time to less than 20 hours. "Direct re-entry from GEO is another possibility, which reduces rescue time to about 6 hours," Kline said.

The final rescue method or combination of methods that would be used will depend on the "risk definitions" for a particular vehicle. Kline concluded that sound design and technology is of crucial importance, "a vital key to helping us capitalize on the Shuttle and evolve toward effective utilization of space." □

	LEO	GEO
• RADIATION PROTECTION – CABIN		 EPOXY TILES (5mm) ~ OUTSIDE ALUM SHELL (8mm TOTAL) TANTALUM (0.5mm) ~ INSIDE
– SOLAR FLARE SHELTER	———	SHELL = 150mm ALUM
• VOLUME PER MAN		
– CABIN	8–10m^2	8–10m^3
– SOLAR FLARE SHELTER	———	0.6m^3
• RESCUE – MAX DELAY	5 DAYS	30 DAYS
• MAINTENANCE		
– BY EVA	ACCEPTABLE	VERY LIMITED
– COST PER MAN HOUR	$2,500	$9,000
– TRANSPORT COST OF RECYCLED COMPONENTS	$1,000–1,800/kg	$10,000/kg

Habitation Requirements

Developing Hardware to Support Life on Long-Term Space Missions

On a year-long mission in space, carrying oxygen and water for the crew would be cumbersome and unwieldy. With ideas for future piloted interplanetary missions and a permanently inhabited space station, NASA has faced the task of providing air and water by setting up the Regenerative Life Support Evaluation, work being done by a group of scientists and engineers at Johnson Space Center.

There, flanked by man-sized machines and tanks, the scientists are testing pre-prototype versions of water and air loops that will someday leave for space. "When they say space station, we're ready," said Nick Lance, an engineer at JSC.

For drinking water, squeamishness is set aside. The crew's urine is mixed with flush water, treated with iodine to prevent ammonia formation, then fed into a zero-g storage tank. From there it is fed into "the still," a distillation unit designed for use at zero-g. The liquid cycles through the still until 96 percent evaporates. Solids come out as a gel, concentrated and kept in a tank to be dumped into space later, though there is talk of someday removing the salts and using it as fertilizer.

"Right now, they're carrying two tanks on the Orbiter just to store urine," said Dot Fricks, a NASA chemist. "We're concentrating the waste down into one small package and using the water over again."

She adds that the system uses little energy. "We are able to boil the water at about 80 degrees by evacuating the shell to a low pressure, around 20 mm of mercury. That way the motor that turns the still provides enough heat to evaporate the water."

Fricks herself has never drunk the water, but she asserts it is chemically more pure than that from a tap. "Here at JSC, we don't post-treat it, and it would have too much acid to drink. A later version will have ion exchange resin beds to control pH and an iodine system downstream that will work the way a commercial system uses chlorine."

She adds that "probably once you were used to it, after a day or two, you wouldn't even think about it."

Tests in October showed that the drinking water system is cost-effective if a flight is 30 days or longer.

On the air side, again, equipment is in pre-prototype stages, meaning the next edition will be prototype, then flight hardware. A water electrolysis subsystem, first of three major components in the air loop, produces hydrogen and oxygen. Oxygen is sent to the crew cabin, hydrogen passes to the next subsystem — the carbon dioxide concentrator.

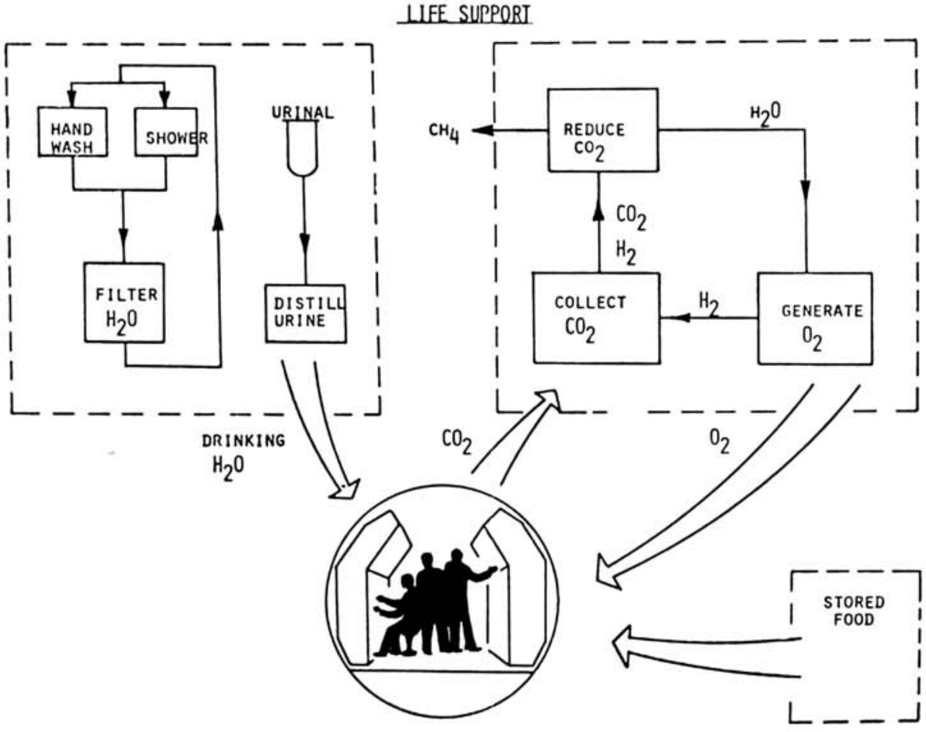
Carbon dioxide and oxygen enter the second subsystem from the cabin. In the concentrator are a number of cells, each cell made up of two electrodes and an absorbent matrix. Carbon dioxide and oxygen blow over the electrodes, reacting and generating power. In the cell, the carbon dioxide becomes a charged molecule, a carbonate ion, which passes through the electrode membrane and reacts. At the second electrode, it comes out carbon dioxide again, only transferred from the air to a stainless steel line. Meanwhile, air minus the carbon dioxide has gone back to the cabin.

Next, carbon dioxide and hydrogen pass to the third subsystem, a reactor which combines them creating methane and water. The methane, at this time, is dumped into space, though there is talk of someday using it as a propulsive fuel.

Water leaves the carbon dioxide reduction subsystem and returns to the first step, to be used in electrolysis, closing the loop.

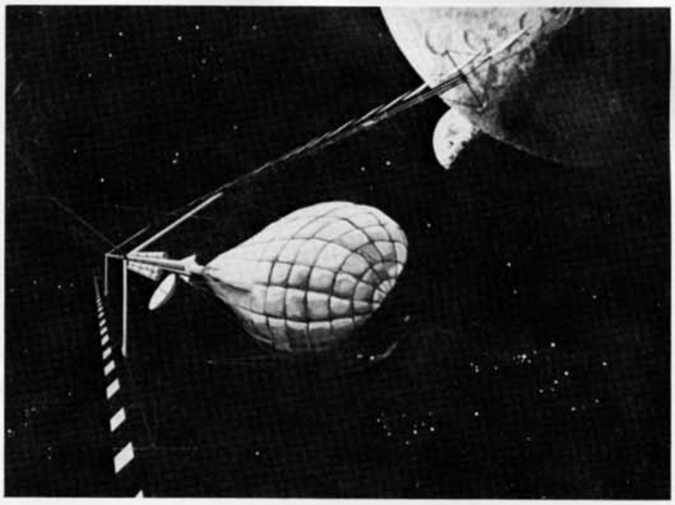
The first air subsystem arrived at JSC in the fall, and has been tested with good results. The second unit arrived in December and still sits, unpacked, in boxes. Lance's work for the next months will be studying how to test the equipment, how to keep conditions right for later tests.

The entire closed life support system will make little noise, comparable to a pump room, or an air conditioning unit operating unnoticed in a home. On a spacecraft, everything depends on saving power and saving weight. Regenerative Life Support is designed to take everything that a person gives off and put it to use.



Space Processing: A New Study

By Mark Hopkins



Mass drivers have a wide variety of potential applications.

At the Massachusetts Institute of Technology (M.I.T.) on October 17, 1978, General Accounting Office (G.A.O.) representatives Ed Fritts and Alan Byroade listened attentively to a series of attacks by materials scientists on the STAMPS (Scientific and Technological Aspects of Material Processing in Space) report. Readers of the L-5 NEWS may recall from an article in the August 1978 issue that this recently completed National Academy of Sciences study has generated considerable controversy because of its pessimistic conclusions about the possibility of economically producing materials in space in the near future. The G.A.O. is currently sponsoring a series of small meetings with scientists around the country in order to provide input for their newly initiated study of near-term space processing. The study will, to a lesser extent, also consider longer-run space options. Publication of the final report is expected in the summer of 1979.

Outrage was expressed at M.I.T. because of the extent to which participation in the STAMPS study was dominated by physicists and chemists. It was felt that under these circumstances it is not surprising that the conclusions of the report were more favorable for scientific experiments than they were for more practical applications.

One materials scientist condemned what he felt was a general philosophy in the report: namely, that the theory had to be well understood before it could wisely be applied. He pointed out that the theory was not well understood even for products currently made on Earth. Advances in science often occur **because of** experiments in which the results are not entirely predictable. In his view, a similar approach should be tried in space.

Dismay was also expressed because of the United States' deteriorating position in materials science. We are clearly behind Russia, West Germany, and Japan. The potential for space processing was seen as one of the few remaining American advantages. Failure to exploit such an advantage would be foolish.

Along these lines, it was pointed out that the conclusions of the STAMP report are inconsistent with the substantial commitments that the Russians, Europeans, and Japanese have made to space processing. If it pays for them, why not for us?

Space processing was not the only area covered at the meeting. According to Professor Henry Kolm, mass driver-related technology has a wide variety of potential applications in addition to those with which space colony enthusiasts are familiar. These possibilities include launching planes from short runways and providing rapidly advancing troops with supplies fired from bases that are miles behind the front lines. Another possibility is to use the mass driver instead of the first stage of a rocket for transporting payloads from Earth to space. In this instance, a long track would be built along which a rocket would be electromagnetically accelerated. After the rocket left the track and glided to a considerable height, it would ignite and carry the payload the rest of the way into space.

One question raised several times at the meeting was, "Why didn't private enterprise provide the funds for space processing if it is such a worthwhile endeavor?" High risks and troublesome externalities seem to be the chief obstacles to private investment. The risks involved are not completely known. But suppose there are 1,000 possible independent investments of equal size, each of which has a 50% chance of eventually leading to a marketable product. Further, assume that one third of these investments are successful. Then a reasonable rate of profit can be obtained. For example, if an investing organization is large enough to make all 1,000 investments, the risk of not making a reasonable profit is almost zero. However, if the organization can raise the capital for only one of the investments, the risk is very high, namely, a 50% chance of losing everything. This example demonstrates how private companies can be discouraged from making investments by such risks, but how a large organization, such as the government, stands to make a profit while absorbing the losses.

Externalities occur when all of the benefits from an investment cannot be captured by the funding organization. However, consumer prices charged for the products and subsequent spinoffs are benefits that a company would be unlikely to receive in a space processing development program. Also, history tells us that despite patent protection, some of the technological benefits developed by one company are likely to be captured by other companies. So, externalities are particularly high for long-run technological investments, such as those which are currently available in space processing.

Clearly, a company will not make an investment if it can't capture the benefits. Thus a decision to leave space processing entirely in the hands of private enterprise is likely to mean that many programs which would be worthwhile for the nation as a whole will not be invested in because of high risk and large externalities. If further government-sponsored development occurs, then risk and the extent of the externalities would be reduced, leading to an increasing degree of private enterprise participation in the future. In any case, the results of the new G.A.O. study will be eagerly awaited by all who are interested in future space processing.

New Space Legislation

by Ken McCormick

The coming year in Congress promises to be a busy one for supporters of the space program, with the introduction of far-reaching space legislation and the struggle to keep the already severely-restricted NASA budget intact. Here's what's taking shape in legislation.

Space Policy Bill — Senator Adlai Stevenson's (D-Ill.) Subcommittee on Science, Technology and Space will hold hearings January 25th and 31st, and February 1st to consider space policy bills to be introduced by Senators Stevenson and Schmitt (R.-N.M.). Both bills were originally introduced during the last days of the 95th Congress, at about the same time that President Carter was announcing his new space policy.

Reportedly, there has been a great outcry from the aerospace community in opposition to Schmitt's call for the establishment of "orbital civilization" facilities during the 1990's and piloted Mars and Venus missions. His new version of the bill is expected to avoid the mention of the term "orbital civilization," and will probably speak more generally about the exploration of the solar system over the next 30 years. The bill's section on aeronautics will also be greatly expanded. Broad guidelines for an increase in funding for the space program, included in the bills, are already very controversial.

Senator Stevenson's bill outlines an ambitious program for the next 10 years which is similar, in some respects, to Schmitt's program for the immediate future. It includes provisions for the design and construction of large structures in space for the purposes of communications, remote sensing, and experimentation in electric power generation and human habitation. The bill also calls for experiments to be conducted in the area of space manufacturing, and for continued U.S. leadership in space science and space exploration.

A space policy bill will almost certainly be voted out of committee for consideration by the full Senate. It may represent a compromise between the Stevenson and Schmitt bills. If so, it will very likely resemble the Stevenson bill more closely, which now has wide support on the committee.

Earth Resources Data Services Bills — Senators Schmitt and Stevenson will also introduce bills to establish organizations for the purpose of gathering and disseminating earth resources data from satellites. Senator Schmitt calls for the creation of a private corporation modeled after COMSAT. Senator Stevenson would like to establish the service first within NASA; he would then move to transfer the service to a private corporation, government corporation, or federal agency within seven years. Hearings are scheduled for March 29th and 30th.

Space Industrialization Act — Representative Don Fuqua (D.-Fla.) will introduce legislation to establish a space industrialization corporation in order to foster profitable ventures in space by reducing entrepreneurial risks. The corporation would find promising industrial ventures and would derive profit from successful projects. Hearings are expected in the House this May.

SPS Bill — Representative Flippo (D.-Ala.) intends to re-introduce legislation to speed research into the SPS energy option. Hearings will be held in the House on March 22nd. However, SPS proponents say their efforts this year will be concentrated on the Senate, since an SPS bill is expected to cruise through the House if the Senate okays it. Who will sponsor SPS legislation in the Senate is unclear at this time.

Budgetary pressures are expected to be extreme this year. If these bills appear to be big spending programs, it could prove disastrous. In fighting for the passage of these bills and for the NASA budget, supporters say they will stress the fact that spending on the space program fights inflation and provides jobs by advancing industrial technology. Whether Congress will heed this argument remains to be seen.

AIAA & SPS

by Ken McCormick

At a press conference at the National Press Club in Washington D.C. this past Jan. 10th, Dr. Jerry Grey, public policy administrator for the American Institute of Aeronautics and Astronautics, supported the solar power satellite (SPS) bill of Representative Flippo. He also expressed reservations about the Department of Energy's SPS program plan and SPS provisions in space policy bills introduced by Senators Harrison Schmitt and Adlai Stevenson III. Grey outlined AIAA's recent position in a paper on SPS, the full text of which appears in the January issue of the AIAA's *Astronautics and Aeronautics.* He said that the Institute advocates the expenditure of $30 million annually for ground-based SPS research, which would lead to a decision whether or not to proceed with SPS development and demonstration.

In reference to D.O.E.'s present research efforts, Grey said, "AIAA believes that establishing a baseline design for SPS at this time would be premature by at least several years, since it might foreclose a host of promising innovative options." Grey also expressed the opinion that the present effort is at too low a level to draw proper conclusions about SPS, and it could drag on for years without developing the necessary technical verification.

Therefore, the position of AIAA is almost identical to the postion taken by Rep. Flippo in his SPS bill. The AIAA's only reservation about the Flippo bill regards the bill's title which refers to "demonstration and development." The text of the bill sets out a research plan leading to demonstration and development, and it is this that the AIAA supports.

Grey said that he was afraid Schmitt and Stevenson were trying to "put the cart before the horse" in providing for an SPS demonstrator in orbit if ground-based studies indicate that SPS is environmentally safe and economically attractive. It is AIAA's position that the necessary ground-based technology verification should be completed before a decision is made on whether and when to proceed with an in-orbit demonstrator. Grey pointed out that opposition to SPS legislation has focused on demonstration and development.

Space Day in New Orleans

By Chuck Landau

Space Day in New Orleans was an unqualified success, despite a cold snap that dropped temperatures from the 80's to the 40's overnight. A well-planned publicity campaign brought approximately 10,000 people to the NASA Michoud Assembly Facility on December 9th for an open house.

A brief outdoor dedication was held for the first stage Saturn V rocket which was being placed on permanent display in New Orleans to honor the space program's progress. This was the last of America's largest rockets, so successful in the Apollo and Skylab programs, but mothballed due to economic considerations. Apollo 13 astronaut and Space Shuttle pilot Fred Haise joined local dignitaries in reviewing the progress to date, and in forecasting an increased interest in the space program with a matching increase in funding.

Inside the space hardware manufacturing and assembly building, exhibits on all aspects of the space program were on display. Movies, literature, and models of the Space Shuttle, Skylab, Apollo, High Energy Astronomy Observatory, Large Space Telescope and Landsat programs were interspersed with exhibits of the Skylab experiments designed by high school students. Moonrocks, encased in a glass pyramid, were a major attraction.

The manufacturing and assembly of the external fuel tank for the Space Shuttle occupies a major segment of this facility. A tour covering all phases of operation in the forty-three acre building was mapped out, and explanations and diagrams explaining the functions of various machines were posted. Friendly employees and their families were on hand to explain procedures and answer questions.

A tentative decision to make this NASA open-house an annual event indicates a welcome shift in policy. Only an informed and vocal public can save NASA and the exploration of space from devastating budget cuts.

An outdoor dedication was held for the first stage Saturn V rocket, now on permanent display in New Orleans.

NEWS BRIEFS

ARMED GUARDS POSTED AROUND SHUTTLE

In a story which appeared in the December 26, 1978 edition of the *Washington Star,* aerospace journalist Dick Baumbach reported that Rockwell International has posted security guards around the Shuttle Orbiter spacecraft in order to protect it from damage, either due to malicious sabotage or accident. The thermal protection tiles are very fragile and can be damaged by a fingernail tap.

I. L. Smith, Rockwell's director of production operations, was quoted as saying: "After we get this spaceship out of here, sometime in late February, we won't have anything to do until August. That could mean we will lay off some people. Sometimes workers think it's better to do something stupid so they can have their jobs last longer. It's that simple."

Baumbach reported that instances of damage to the Orbiter have all been accidental so far.

LEAN DAYS AHEAD — NASA'S 1980 BUDGET

Austerity was emphasized in the NASA $4.6-$4.8 billion Fiscal 1980 budget. No new flight program starts will be allowed in Fiscal 1980, forcing some of the new programs into budgets for 1981 and 1982; this will cause further schedule problems with programs slated to start in *those* fiscal years. As a result, NASA will not be allowed to request the 25 kw power module (which would greatly expand Shuttle activities) in Fiscal 1980. The Office of Management and Budget (OMB) wished to delay the power module until Fiscal 1981, allowing only for some early development expenditures in the Fiscal 1980 budget.

Should the power module be pushed back to Fiscal 1981, it would be placed in direct competition with the planned thrust augmentation of the Shuttle, something vital to the launch of 32,000-lb. USAF satellite reconnaissance payloads. The Department of Defense and NASA may have to make funding tradeoffs in order for the thrust augmentation to be made in Fiscal 1981.

Worse yet, the Venus orbiting imaging radar mission (VOIR) might also have to be pushed into Fiscal 1981, placing it in competition with yet another high-priority mission, a spacecraft that could drop a probe into Halley's Comet and then go on to rendezvous with Comet Tempel 2. If the Halley probe/Tempel 2 spacecraft is not started in Fiscal 1981, both comets could not be studied by the same spacecraft. Two separate spacecrafts would be required, making the study much more expensive.

A further complication in this whole budget matter is timing. With a rather imperfect knowledge of celestial mechanics, OMB did not take into consideration the fact that if VOIR fails to get a Fiscal 1981 new start, the opportunity for such a study will be lost, and NASA would have to wait until 1991 for another Venus opportunity.

EUROPEAN MOON PROBE DISCUSSED

The European Space Agency (ESA) has encouraged discussion of an all-European Moon probe to be launched early in the 1980s. Called POLO, for Polar Orbiting Lunar Observatory, the spacecraft would be launched by the ESA "Ariane" booster and would orbit the moon from pole to pole at an altitude of 100 kilometers. From this vantage point, the POLO satellite would map lunar magnetic and gravity fields in regions not investigated by American probes in the Lunar Orbiter and Apollo programs. In addition, gamma and x-ray detectors would scan the surface chemistry and geology.

NASA plans for an American "Lunar Polar Orbiter" (the LPO, or, unofficially, "Prospector") have been axed for budgetary reasons. A fall back effort to fly American instruments on a projected Soviet lunar orbiter in 1980-1982 is in limbo, victim of chilled Washington-Moscow diplomacy.

Besides expanding scientific knowledge of regions of the Moon not explored by Apollo, a lunar *polar* orbit satellite could search for one of the most valuable lunar resources of all: ice. Its existence in eternally-dark polar craters is predicted by theory, yet no trace of such icecaps has been found in Apollo research. Scientists had hoped to find evidence for lunar polar icecaps (which would probably be buried under several meters of lunar soil, but which could amount to the volume of water in Lake Erie) either from hydrated lunar grains thrown off the polar regions by meteor impacts, or from bursts of water vapor 'smelled' by instruments left behind at the Apollo landing sites. Neither approach has produced unambiguous evidence of the existence of such polar caps.

European interest in the lunar mission is symptomatic of a new confidence among ESA officials, who are searching for new directions open to European space research. One enthusiastic proposal even called for the launch of a European Moon shot in mid-1980 on the fourth test flight of the Atlas-Centaur-sized Franco-German "Ariane" booster; the payload, which would not be the proposed POLO itself, would have been assembled from backup GEOS-3 satellite parts. But that plan has been rejected, and a more ambitious program of lunar and planetary probes for the mid-1980s is now being prepared for budgetary consideration early next year.

U.S. TO HELP CHINA DEVELOP A SPACE PROGRAM

A delegation from the People's Republic of China has been holding discussions with United States officials since Nov. 28 regarding possible U.S.—Chinese cooperation in the peaceful utilization of space technology.

As a result of these discussions, an informal agreement has been reached in principle on U.S.-Chinese cooperation in the development of the civil communications system of the People's Republic of China. This involves the purchase by China of a U.S. satellite communications system, including the associated ground receiving and distribution equipment. The space portion of the system will be placed in geostationary orbit by the U.S., with continued operation to be carried out in China.

Similar informal agreement in principle has been reached regarding the purchase by China of a ground station capable of receiving Earth resources information from U.S. Landsat remote sensing satellites, including the Landsat-D now under development.

PLANNING BEGINS FOR NEW ASTRONAUT SELECTION

A new call for astronauts may be issued by NASA later this year, according to George Abbey, Director of Flight Operations at NASA's Lyndon B. Johnson Space Center in Houston. Discussing the ongoing training of the current class of 35 astronaut-candidates, Abbey suggested that a new class will probably be selected before the current class graduates in July 1980.

The new group would be smaller than the present one and could be the first of a routine annual astronaut selection process, officials said. Five to ten individuals, either pilots, mission specialists or scientists from a particular discipline, or some combination, would be picked on an "as needed" basis. Announcements would routinely be made early in a given year with a closing date of June 30, followed by a six month selection process. Those chosen as astronaut-candidates would then report for duty on or about the following July 1.

Exact selection criteria and schedules depend upon Space Shuttle progress and upon attrition and retirement from the current astronaut corps. In contrast to earlier procedures, in which military officers were loaned to NASA indefinitely (only two officers ever returned to their parent service), officers from the current crop of 35 trainee-astronauts will probably be with NASA for between five and eight years, after which they will be expected to return to their parent services. This will serve to increase turnover and open new slots for future selections.

Although no formal selection process is under way, the address for inquiries is still in effect: Code AHX, NASA Lyndon B. Johnson Space Center, Houston, Texas 77058.

SPACE MANUFACTURING CONFERENCE

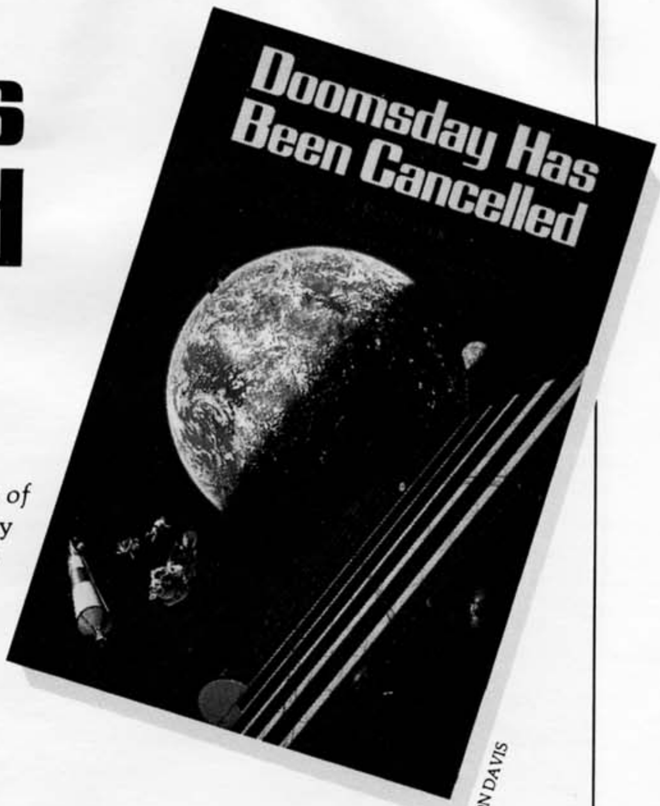
On May 14-17 the Princeton Space Manufacturing Conference will feature the world's foremost researchers in the fields of space industries, habitats and solar power satellites. Hosted by Princeton physics professor Gerard K. O'Neill, the four day event will wind up with a gala "Space Studies Institute (SSI) Subscribers' Celebration" Thursday afternoon.

To register, write to the Princeton Conference Office, 5 Ivy Lane, Princeton, NJ 08540. No registration is required for the public session on Thursday from 9:00-12:00 a.m. SSI subscribers are requested to let O'Neill know if they plan to attend the Celebration.

If you wish to become a subscriber to O'Neill's SSI, send $10 (or more!) to Space Studies Institute, Box 82, Princeton, NJ 08540. SSI funds support space colony research; current emphasis is on the mass driver.

Doomsday Has Been Cancelled

by DR. J. PETER VAJK
with a foreword by RUSSELL SCHWEICKART



DON DAVIS

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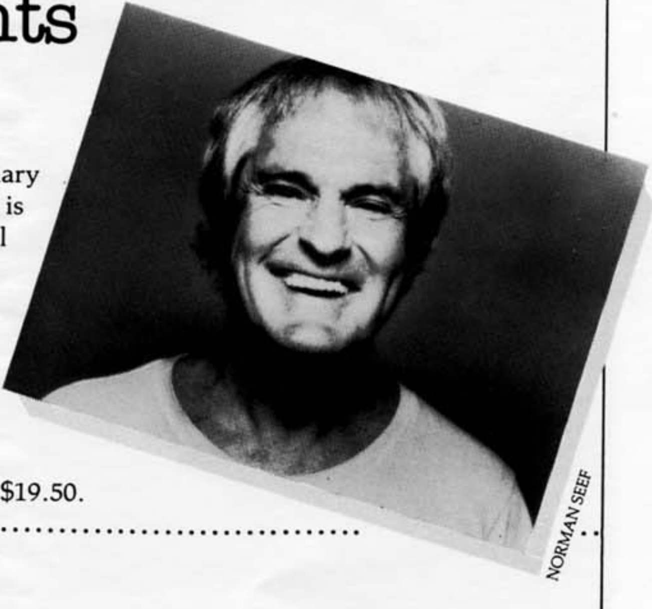

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16th Space Congress Proclaims: Space — Everyone Benefits

In answer to a question which has persisted since the inception of the space program, the 16th Space Congress proudly proclaims SPACE—EVERYONE BENEFITS as its 1979 theme. Under the leadership of General Chairman Curtis A. Stinson, Planning Research Corporation (PRC), and Vice-Chairman Joseph F. Malaga, National Aeronautics and Space Administration (NASA), the steering committee, consisting of members of the government/contractor aerospace team as well as members from the local community, has scheduled this annual symposium for April 25, 26, and 27, in Cocoa Beach, Florida.

The program for the 16th Space Congress will include three panel sessions and six technical paper sessions dealing with such topics as: Space Shuttle and Space Transportation Systems Updates; Spacelab and Other Identified Payloads; Space Applications and Commercialization; and Technology Transfer.

In the aftermath of last year's successful MEET THE ASTRONAUTS panel, plans are being discussed with panel chairman Lee Scherer, Director of Kennedy Space Center, for another exciting Thursday evening session, which will be free and open to the public. More details will follow at a later date.

In addition to the panel and paper sessions, events will include the 16th Space Congress Banquet and Luncheon, the Youth Science Fair, and the space contractor's Exhibit Hall. The science fair and contractor's exhibits are again free and open to the public.

This year, a special registration rate will be made available to students who wish to attend the 16th Space Congress.

Chuck Morley, Publicity Chairman
P.O. Box 1333
Cocoa Beach, Florida 32931
Telephone: 305/867-7731 and 784-0925

Hugh Harris, Alternate
Telephone: 305/867-2468

Inside the L-5 Society

OHIO L-5 CHAPTER STARTING

An Ohio chapter of the L-5 Society is organizing! If you are interested, or have ideas and suggestions for getting together and helping to get to "L-5 in '95," get with it! Write:

Steven Stein
570 Fairhill Drive
Akron, Ohio 44313

Or call him at 614-424-2553.

HOW TO CREATE AN L-5 CHAPTER

by Carolyn Henson

You want to start an L-5 chapter? How do you begin?

1. *Write Headquarters.* Tell us you want to start a local chapter. We'll send you a copy of the L-5 bylaws, a list of people who have expressed an interest in local action, a list of local chapters, membership flyers and L-5 buttons. Be sure to familiarize yourself with the bylaws.

2. *Contact Local Members.* Find out if there's enough interest to have a "get acquainted" meeting. If you can pull that off, the next move is to determine if you have the time, ability and elbow grease to hold a second meeting, this time for the general public. Be certain that you can schedule something interesting: a lecture, slide show, debate, or a movie.

3. *Hold a Public Meeting.* Be sure to order any visual aids well in advance. Put out plenty of publicity; write for the "L-5 Slide Catalog" (for details on how to place public service announcements) and send out press releases. If you send an announcement to L-5 headquarters two months in advance, we'll advertise it in the L-5 NEWS. That may lure in some members who haven't expressed an interest in local action.

Save business for the *end* of the meeting! If you've had a good turnout, it may be appropriate to hold an election of officers.

4. *Elect Officers.* Remember that the officers represent your group both to the public and to the rest of the L-5 Society. Don't elect someone because he/she demands it or promises to donate money. The officers should inspire confidence, should work hard and should be easy to work with. Send your list of officers to headquarters.

5. *Pick a Name.* We have no requirement for names. However, a short, snappy name will get attention. If "L-5" is included in your name, you can take advantage of national publicity. When your friends and neighbors see the L-5 Society on T.V., they'll know you're part of the action.

6. *Initiate Projects.* Your local chapter will be great for making friends and throwing parties. But remember, we're here for a purpose — to get ourselves off the planet! Projects run by local chapters include operating a speakers' bureau (to educate schools, churches and civic groups); setting up displays at fairs, hearings and civic events; sponsoring lectures, films and slideshows; publishing a local newsletter; and forming a political action group.

7. *Money.* How do you keep financial records? First, open a checking account. You'll need our tax number to do that. When you've formed your chapter write the President of the L-5 Society and she'll give the number to you.

The two most important records to keep are of the money you take in (who gave it, how much and what it was given for) and the money you spend (who the check is made out to, how much and what for). With that information recorded in a cash receipts (income) ledger and a cash disbursements (outgo) ledger, you can then determine how much you spent on, for example, your T-shirt project vs. what it brought in, and how much your local newsletter is costing vs. income from subscriptions. That way you can determine which projects are profitable and which are not. Please note that for expeditures over $500, you need approval by the L-5 Board of Directors.

But there's no point in keeping records if there's no money to handle! The most straightforward way to raise money is through local dues. However, it's hard to get people to fork over money for a newly-formed chapter of dubious future. The way you part the doubters from their money is by sales: T-shirts, bumper stickers, posters, even a bake sale! Where do you hold your sales?

Science fiction, mystery and comic fans hold conventions all over the country. Ask them for a "huxter's booth." Often they'll donate the space because you're working for a good cause. And you'll get an audience of hundreds, sometimes thousands, of enthusiastic potential customers and recruits. In Tucson we even got a free booth at a custom car show!

How can you hook up with these conventions *early* and get a *free* booth? Two valuable science fiction trade newletters with all the inside news are: LOCUS, Box 3938, San Francisco, CA 94119 and APOTA, Box 19413, Denver, CO 80219.

For details on how to obtain T-shirts to sell, call: Bob Engelke (toll free) 800-327-5611.

8. *Taxes.* Beware of local sales taxes. In most cases you'll have to pay up in spite of being a "tax exempt" group. Check with your county and state tax people for details.

How can donors to your chapter get a deduction on their income tax? It varies from place to place, but one method always works. Have the donor make out the check to "L-5 Society" and mail it to headquarters with instructions that it is an *earmarked* donation to be sent to *your* chapter. We will deposit it, send a receipt to the donor, and send the fortunate chapter an L-5 check for the same amount.

9. *When Things Go Wrong.* From 11 p.m. to 8 a.m. weekdays, and 11 p.m. Friday to 5 p.m. Sunday long distance phone rates are cheap. Try calling the president of one of those successful L-5 chapters you read about in the L-5 NEWS. They've had worse problems and have lived through them! Yes, you can even call headquarters, but I warn you, we aren't magicians. But we can give advice.

How Can Headquarters Help? We can provide you with free L-5 buttons, posters and membership forms. We also provide copies of the bylaws and the most recent list of those who wish to be locally active.

How To Help Headquarters. Send the L-5 NEWS editor news stories on your successful activities — and bury the mistakes. Scream at your local members if you find out they haven't joined up with the parent L-5 Society yet. Every new member means an improvement in the quality of the L-5 NEWS. And, most important, become a strong force in your community working for the new space program. *Reach for the stars!*

Bylaws Election

In the preceding article on forming a local chapter you will note that there is no step called "Request Approval of Chapter Status." To date, we've never had need of that step; local chapters have been pretty darn good.

But suppose a local chapter runs up a big debt and then dumps it in the lap of headquarters. Do you want part of your dues to be used to pay their bills? Or suppose a crackpot sets up a three-person chapter in your city and makes it a local laughingstock. Then what? Do you want to have to move your L-5 NEWS off the coffee-table and into a closet? As we get more numerous, we cannot be certain that all L-5 chapters will act responsibly and will not harm the interests of other chapters.

At present you can only complain to L-5 headquarters or to L-5 Board members about local chapter goof-ups; but all you will get is advice and sympathy. With these bylaws changes, you can also get some clout: the power to prevent irresponsible people from using the L-5 name, and the power to "defrock" a chapter that goes off the deep end.

With luck we will never have to use these proposed bylaws. But the price of a good organization is constant vigilance and the power to take action when needed.

Carolyn Henson
President, L-5 Society

Bylaws Changes

This is an amendment to the bylaws. The following shall be deleted: Article XIII, Section 6. The following articles shall be added to the by-laws:

Article XIV

Membership

A. The Directors shall have the authority, by resolution requiring a simple majority of a quorum, said vote being taken by any convenient written or electronic means, or at any regular or special meeting of the Directors, to accept an individual or chapter as a member of the organization.

B. The Directors may, by resolution, delegate the authority to accept individual members into the organization to the organization's President. The authority to accept chapters shall not be delegated.

C. Chapters wishing to become members of the organization must present the following:

1. A request for membership.

2. A list of chapter members, at least one of whom is an individual of the organization. This list shall include the mailing address and telephone number of each chapter member.

3. The results of an election of Chapter Officers certified under oath by the official conducting said election.

4. A pro forma financial statement certified under oath by the person responsible for the finances of the chapter.

5. Certified copies of all articles, bylaws or other documents adopted by the chapter.

D. Chapter membership shall be effective upon mailing of a charter to the individual designated as the Executive in charge of the chapter. This charter is and remains the property of the organization and must be surrendered upon its revocation by the Directors or any other dissolution of the chapter. Individual membership shall be effective upon acceptance.

Article XV

Annual Report

Each member chapter shall submit an annual report to the President of the organization on April 12 of each year. This annual report shall be certified by the Executive in charge of the chapter and shall include:

A. A brief description of the activities of the chapter during the past year and its plans for the next year.

B. A list of chapter members as of the report date together with their telephone numbers and addresses.

C. A financial statement.

Article XVI

Suspension and Revocation of Membership

Section 1. Prior to recommending suspension or revocation of membership, the President shall send a written notice to the member concerned. The notice shall include:

A. A brief outline of the information on which the President is acting.

B. The fact that suspension or revocation of membership will be recommended to the Directors unless the member shows cause.

C. A request that the member provide the President with any information the member wishes to have considered by the Directors prior to their acting on the President's recommendation.

D. A time limit for submitting the information.

Section 2. The Directors shall have the authority, by resolution requiring a two-thirds (2/3) vote of a quorum, said vote being taken by any convenient written or electronic means, or at any regular or special meeting of the Directors, to, at the request of any Officer or Director of the organization, suspend or revoke a membership of an individual or Officer shown on the organization's records as being the Executive in charge of the chapter.

Current L-5 Society Bylaws

Article I

The name of this organization shall be the L-5 Society.

Article II

The purposes for which the Corporation is formed are to operate exclusively for charitable and educational purposes, namely to promote space colonization. In furtherance of these goals the corporation may:

A.
1. Educate the public with technical and general information.
2. Conduct research.
3. Fund research by others on solar energy, space colonization and related areas.
4. Prepare models for use in space and participate in their use.
5. Carry out other activities in furtherance of these goals.

B. In order to carry out and achieve the foregoing purposes the Corporation may:
1. Receive, hold, administer, lend and expend funds and property.
2. Make contracts.
3. Solicit, collect, receive, acquire, expend, invest and lend money and property, both real and personal, received by gift, contribution, bequest or otherwise.
4. Sell and convert property, both real and personal into cash.
5. Use the funds of the Corporation for any of the purposes for which this corporation is formed.
6. Purchase or acquire, hold, use, sell, exchange, assign, convey, lease or otherwise dispose of and mortgage, or encumber real and personal property.
7. Borrow money with or without security and to incur indebtedness and secure the repayment of the same by mortgage, pledge, or deed of trust on real property or personal property of the Corporation.

C. The foregoing statement of purpose shall be construed as a statement of purposes and powers and the purposes and powers in each clause shall be regarded as independent purposes and powers. Notwithstanding any of the above statements of purposes and powers, this Corporation shall not engage in activities which in themselves are not in furtherance of the charitable and educational purposes set forth in paragraph A of this article.

Article III

Membership

Section 1. Regular membership in the organization shall consist of all who are willing to serve, attend meetings of the membership, vote, and who have contributed dues for the current year.

Section 2. Student membership in the organization shall be limited to those who are enrolled in a recognized academic institution and shall be entitled to all the privileges and prerogatives of regular members.

Section 3. Institutional membership in this organization is open to all organizations and corporations. Institutional members shall be entitled to all of the privileges and prerogatives of regular members, except that they may not vote at elections, hold elective office in the organization or act as chairman of a standing committee.

Section 4. Nonmembers may attend and participate in all open meetings, social gatherings, and any regular activities of the organization, except that they shall not have a vote in any decisions, and may be required to contribute their fair share toward any expense incurred through such participation.

Section 5. The powers of the members of this organization shall be limited to those usually held by stockholders of a commercial corporation, as such powers may be further limited by the laws of Arizona and the U.S.A. for members of a nonprofit corporation.

Article IV

Dues and Assessments

Section 1. The annual dues for each member of the L-5 Society shall be determined by the Board of Directors.

Section 2. There shall be no general or special assessment levied against the membership, unless approved by a two-thirds (2/3) vote of all members after discussion at a duly constituted meeting. This provision, however, shall not prevent any member or group of members from making voluntary donations to the organization for the support of specific projects.

Article V

Meetings of Members

Section 1. There shall be at least one (1) regular business meeting of the membership each year, which will be the Annual Election meeting. Special meetings of the membership may be called at any time by concurrence of at least three members of the Board of Directors. The Secretary shall notify members by mail of the time and place of each meeting, at least two weeks in advance. Such meetings may be conducted by mail or by phone.

Section 2. Business of the organization may be transacted at any meeting attended by not less than three members, hereinafter called a quorum, of the Board of Directors. This meeting may be held over the telephone or by mail, with all decisions mailed to the three or more Board Members at that meeting for majority vote in order to be valid.

Section 3. A simple majority vote of a quorum shall decide all issues calling for a vote, unless a greater number shall be required by law or these bylaws. Only paid-up members shall be entitled to vote at these meetings, and each member shall have only one (1) vote on each issue. Votes for amendment of the Bylaws or Annual Elections, and upon demand by any member, the vote on any other question before the meeting, shall be by written secret ballot. Members may vote by U.S. Mail and members shall not be required to be present at any meeting to vote thereon provided notice is given to each member and such notice includes full particulars of the nature and extent of the issue to be voted on.

Section 4. The rules contained in Robert's Rules of Order, Revised shall govern all meetings of the organization in all cases where applicable and not inconsistent with these Bylaws.

Section 5. The authority to approve policy positions, statements on behalf of the L-5 Society, and institution of new programs shall be reserved to the Board of Directors.

Section 6. The decisions reached by duly constituted meetings of the membership shall be binding upon the Board of Directors and shall be executed by the officers to the best of their ability. No member or group of members other than said Directors or Officers shall approach any outside organization or act as representative of the organization without the prior approval and authorization of the Board of Directors granted at a regular or special meeting of said Board.

Article VI

Board of Directors

Section 1. The Board of Directors shall consist of at least five qualified members of the organization who are duly nominated and elected to Directorship by the members at large at an annual election as hereinafter provided. The term of office shall be one (1) year, beginning with the Annual

Meeting.

Section 2. Any vacancy on the Board occurring through death, resignation, disqualification, or any other cause, may be filled for the unexpired term by an affirmative vote of the majority of a quorum of the remaining directors.

Section 3. A Board member may be removed for just cause by a majority of the Board.

Section 4. The Directors shall meet whenever required, at the time and place or by telephone or mail upon written or telephoned request of three or more of the elected officers. Verbal notification to all Board members may be given in any manner necessary to assemble a quorum.

Section 5. Any three (3) members of the Board of Directors shall constitute a quorum for the transaction of the business of the Board.

Section 6. The business of the Board of Directors shall be conducted in such order as the Board may from time to time determine by resolution.

Section 7. The Board of Directors shall have the management and control of the operation of the organization. The Board may exercise all of the powers of the organization, and do all such lawful acts as it deems necessary of the membership as prescribed by these Bylaws and the laws of the state of Arizona and the U.S.A.

Article VII
Officers

Section 1. Officers of the organization shall be a President, Secretary and Treasurer, and Coordinators as needed and authorized by the Board of Directors. As soon as practical after the Annual Meeting and election of the Board, The Board shall nominate and by majority secret ballot elect from the members of the Board the Officers. Each Officer's term of office shall be coterminous with and dependent upon each Officer's tenure as a member of the Board, except that a retiring Officer shall continue to serve until replaced by the new Board.

Section 2. Officers who resign or otherwise vacate their position may be replaced by the Board, using the procedure in Article VI, Section 2 above.

Article VIII
Duties of the Officers

Section 1. President. The President shall preside at membership meetings. The President shall have charge of the business of the organization and shall administer all affairs of the organization in accordance with the Charter and these Bylaws, and shall act as official spokesperson of the Society, but in all cases the President shall be bound by the policy established by the Annual Meetings and the Board of Directors. The President shall sign all contracts, appoint the Chair of all committees responsible to the President, and may sit as an ex officio member of all committees.

The President may, with approval of the Board of Directors, hire and appoint an Executive Director, to whom may be delegated operational responsibility for such duties as may be appropriate.

Section 2. The Secretary shall maintain records of the proceedings of all meetings and shall discharge such other functions as the President or the Board shall direct. The Secretary shall carry out official correspondence, preserve written records (except financial records), keep the membership roll, provide notice of meetings of the Board or the Society, and shall receive, verify and record all votes of the Board or Annual meeting. The Secretary shall have charge of maintaining and supplying copies of the Charter, these Bylaws, and other official papers of the Society.

Section 3. Treasurer. The Treasurer shall receive, record, and safeguard all monies paid into the organization, including collection of dues. That person shall keep full and accurate books of account for all financial transactions of the organization, and shall render a financial report when called upon by the Board of Directors or the membership. That person shall open the books for inspection at any time deemed necessary or desirable by the Board of the membership. The Treasurer shall pay all bills duly approved by the Board of Directors. The Treasurer shall prepare and present to the Board of Directors an Annual Financial Report, covering all transactions for the calendar year, July 1 through June 30. The Treasurer shall inform the Secretary of all new memberships and dues paid, as needed.

Section 4. Coordinators. They shall be chosen by majority vote of the Board of Directors to head up specific projects as needed.

Section 5. All correspondence, conveyances, encumbrances, releases, discharges, contracts, or obligations of the organization, of every nature and description shall be executed or countersigned by the President, unless the Board of Directors otherwise directs.

Section 6. Local Chapters. The Board of Directors of the L-5 Society shall recognize any local chapter that has at least one member of the L-5 Society in it and whose activities are in agreement with the Articles of Incorporation and the Bylaws of the Society. Local chapters may include members who are not members of the L-5 Society. Each local chapter shall elect a President, Secretary, and Treasurer. The Secretary of the local chapter shall be responsible for keeping the L-5 Society informed of the local chapter's activities. The Treasurer shall provide the parent organization with the financial records of the local organization when requested by the Board of Directors. Local chapters shall have the right to establish additional bylaws regarding their chapter, providing that the bylaws do not conflict with the Bylaws or Articles of Incorporation of the L-5 Society. The local chapters shall have the right to determine how locally raised money is to be used, providing that its use does not conflict with the Bylaws or Articles of Incorporation of the L-5 Society. The L-5 Society shall, upon

Place
Postage
Here

The L-5 Society
c/o Arizona Research & Associates, Inc.
317 E. Jacinto St.
Tucson, Arizona 85705

(This address is only to be used for this election.)

request of any of its members, provide the names and addresses of the nearest local chapters. The tax status of the L-5 Society shall also cover the local chapters which are recognized by the Board of Directors. If the Board finds that a local chapter has engaged in activities in violation of the Bylaws or Articles of Incorporation of the L-5 Society, it shall revoke its recognition of the local chapter. Any local chapter which is not recognized by the L-5 Society shall not fall under the tax status of the Society, nor shall the Society be held responsible for its actions.

Article IX

Expenditures

Section 1. All proposed expenditures up to and including $500 may be approved by the Coordinators responsible. All proposed expenditures exceeding $500.00 shall be approved by the Board of Directors prior to actual disbursement.

Section 2. All expenditures are subject to review by the Board of Directors at any meeting.

Section 3. The Board of Directors is responsible for maintaining appropriate records to account for all property purchases for or owned by the organization.

Article X

Annual Elections

Section 1. At least one month prior to the Annual Meeting, the Board shall appoint a nominating committee, at least three of whom are not current members of the Board of Directors.

Section 2. Not less than one week prior to the Annual Meeting, the Chairperson of the nominating committee will provide the Secretary with the names of the selected nominees, and the Secretary will notify the membership of the time and place for the meeting, and the names of all current Directors and nominees.

Section 3. At the Annual Meeting, the Chairperson of the nominating committee shall place in nomination the slate of candidates selected. Thereafter, the membership at large may make additional nominations from the floor, and the Secretary shall place in nomination any names proposed by absentee ballot. All such nominees who do not personally decline shall comprise the slate of candidates for election to the Board of Directors.

Section 4. Voting shall be by mail or secret ballot. Each ballot shall be returned to the Secretary, who shall certify the election of each person who shall obtain a majority of votes from among those voting.

Section 5. The President shall cause to be announced in the next available issue of the Society Newsletter the names of such persons as are elected to the Board.

Section 6. The Annual Meeting will be held in June, or earlier if decided by a majority vote of the Board.

Section 7. A special election to elect additional members to the Board of Directors may be called at any time by majority vote of a quorum of the Board of Directors.

Article XI

Amendment of Bylaws

The Bylaws of this organization may be adopted, amended, or rescinded in whole or in part by a three-stage procedure as follows:

A. Approval by majority vote of a quorum of members at any duly constituted regular or special meeting of the membership, or by majority vote of a quorum of Directors at any meeting of the Board of Directors.
B. Publication by U.S. Mail to all current members, of the intention to make, amend, or rescind the Bylaws, with a brief outline of the proposed changes, and notice of time and place for a regular or special meeting of the membership to vote on the proposed changes.
C. Final approval by a two-thirds (2/3) majority vote of a quorum of members present at a duly constituted meeting of the membership, to be held not less than one month following notification as required above or by two-thirds (2/3) vote of those responding by mail if the vote is held by mail.

Article XII

Indemnification

The L-5 Society, by resolution of the Board of Directors, provides for indemnification by the association of any and all of its Directors or officers or former Directors or officers against expenses actually and necessarily incurred by them in connection with the defense of any action, suit, or proceeding, in which they or any of them are made parties, or a party, by reason of having been Directors or officers of the L-5 Society except in relation to matters as to which such Director or Officer or former Director or Officer shall be adjudged in such action, suit, or proceeding to be liable for negligence or misconduct in the performance of duty and to such matters as shall be settled by agreement predicated on the existence of such liability for negligence or misconduct.

Article XIII

Dissolution

The L-5 Society shall use its funds only to accomplish the objectives and purposes specified in these bylaws, and no part of said funds shall inure, or be distributed, to the members of the L-5 Society. On dissolution of the L-5 Society any funds remaining shall be distributed to one or more regularly organized and qualified charitable, educational, scientific, or philanthropic organizations to be selected by the Board of Directors.

Clip the postcard below to cast your vote in the Bylaws election. Votes will be counted on March 15 and the results will be published in the **L-5 News.**

L-5 Society Bylaws Election

☐ Yes, I approve the Bylaws amendments.

☐ No, I vote against the amendments

Reasons or comments:

Membership number ______________

(This number appears in the upper right corner of the address label on this **L-5 News.** To insure secrecy of your ballot, this portion of the card will be removed after verification by a disinterested third party. The ballots will then be counted by Prof. Jack Salmon, secretary of the L-5 Board of Directors.)

L5 NEWS
March 1979

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY
VOL. 4 NUMBER 3 MARCH 1979

In this issue:

Jennifer L. Atkins,
Randy Clamons,
Carolyn Henson,
Alcestis R. Oberg,
Editorial Staff

Carolyn Henson,
William Weigle,
Administrative Services

Board of Directors:
Isaac Asimov
Barry Goldwater, Sr.
Robert A. Heinlein
Barbara Marx Hubbard
Gordon R. Woodcock
Philip K. Chapman
Arthur Kantrowitz
Konrad K. Dannenberg
Edward R. Finch, Jr.
J. Peter Vajk
Jack D. Salmon
Harlan Smith
Norie Huddle
Mark Hopkins
H. Keith Henson
Carolyn Meinel Henson
William Weigle

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L-5 Society
Membership Services
1620 N. Park
Tucson, AZ 85719

1 **Bound For Glory** *Want to go up into space? Keith Henson tells how.*

2 **Government Rip-Off?** *by Jennifer Atkins. What's the real story behind the 1978 Solar Energy Policy Forums?*

3 **Notes on the "Great Adventure" Movie** *by Ken McCormick.*

4 **Space Shuttle Club of Japan** *by Iwao Eto.*

DOE Moves Powersats to Front Burner *Carolyn Henson reports that the Department of Energy is warming up to SPS.*

5 **Space Policy** *by Ken McCormick. Representatives of business and industry sound off on Carter's policy. Senators Schmitt, Stevenson and Press debate the issues.*

7 **Quiet Colony**

8 **The New Space Program** *Philip K. Chapman discusses the space program in the perspective of the future of humankind.*

9 **Life Support Workshop** *by John M. Phillips*

10 **Skylab** *by Jennifer Atkins. An update on the falling satellite — what is and isn't being done.*

12 **International Satellite Industries, Inc. Launched** *by Carolyn Henson*

13 **Of Interest:**
Register Now for Princeton Conference
Detroit L-5
L-5 at Lehigh

Letters

Cover: Skylab: the abandoned ship. (See **Skylab** by Jennifer Atkins, page 11 of this issue).

Bound For Glory

by H. Keith Henson

"What should I do to improve my chances of going?" In the last four years, giving perhaps 100 lectures on space colonies, this is the most persistant question I have been asked.

It's a hard question because (among other obvious reasons) the answer depends on who does it. For example, were the Japanese to build space industries out of their balance of payments excesses, learning Japanese and the proper way to drink green tea might be the most important thing you could do. If the U.S. government does it, joining one of the armed services could be a smart move (veteran preference in civil service). A private enterprise outfit with too many eager job applicants might want you to be an early stockholder. I admit to being partial to a company doing the job. It decreases the chances of job applicants (like me) having to put up with psychologists prodding us with electric shocks while we try to solve problems hunched over in the dark! The social scientist types have just too much hold on the government.

What causes space to be settled and how it is done makes a difference, too. Your expertise as a turbine blade machinist will be of little avail if solar cells turn out to be the power generation method of choice for solar power satellites. Likewise, your years of research in purifying and dopeing semiconductors won't help much if turbines are the way to go. Even your deep knowledge of phased array radar won't help if they bring the energy down by laser or turn it into antimatter and bring it down in a bag. If some massive breakthrough in fusion makes SPS unattractive, manufacturing planetary sunshades (to compensate for waste heat) or illiminators (to ward off an ice age) may be the requisite skills. You are just going to have to keep up on developments.

Of course, if it takes 50 years, and no longevity breakthroughs are made, about all we can do is save up to buy a retirement place in "Sun City in the Sky."

Other factors that might have an effect on your chances are hard to change. Females and minority groups probably have a better chance (provided the current social action plans remain in effect), but sex change operations and allover tatoos are not recommended. Lots of money is another way. With enough money you can build your own space colony, but please, no more bank robberies!*

"Well, what can I do to improve my chances?", I hear you say. Here's my list. Add what you will, or make your own.

Education: Get a solid practical knowledge of elementary physics and chemistry. You need not be an expert, but your life, and the lives of those around you will depend on sound judgement of physical and chemical effects. I think that for the first few years no one, including the gardener and the cook, will go without a college sophomore level knowledge of these subjects. If you are not up to this level, consider your local community college or correspondence courses. Anybody who can multiply three numbers together can figure the force on an airlock door.

Experience: Work on the Alaskan gas pipeline, or spend a winter at McMurdo sound in Antartica. A tour of duty on a Polaris submarine would be ideal. Work on an offshore oil rig might suffice, or some other really isolated place. Many years ago I put in some time with a geophysics crew in the near vacuum (7psi) of the Peruvian Andies. I found that some people like isolation, some are indifferent, and some go stark raving mad! Find out. It's embarassing, not to mention expensive, to be shipped back. (If you don't like isolation, wait till the second or third group goes up. By then the discotheque will be open.)

Health: If you smoke (tobacco that is), quit. 1) It's dangerous to your health in a space habitat. Non-smokers may ask you to smoke outside. 2) You may not live long enough to go.

Otherwise stay in good shape. Get a first aid card. Your local Red Cross offers classes for a small charge.

Hobbies: Try mountain climbing (with ropes), or skydiving, or hang gliding. Learn to fly a light plane, or learn scuba diving. Occupation as a miner, fire fighter, or farmer might substitute.

All of these have a tendancy to maim or kill the careless (and sometimes even the careful), but they do teach the importance of doing things right. Be sure to get qualified instruction, pay attention, and be careful. There is a saying in aviation, "There are old pilots, and bold pilots, but no old, bold pilots."

Miscellaneous skills: Learn to cook. If you don't know how, help someone (who does know) to butcher a hog. You never can tell when such a skill will come in handy. In the middle of the night on a recent business trip to Iowa, I came upon someone who had just run over a hog. The highway patrol told the guy who had run over the hog that he couldn't leave it there, so I cleaned it and he took it home. (I would have taken it, but American Airlines won't check a dead hog). Not only is this a useful skill, but you will improve your LLQ.**

And if in spite of all our efforts we end up stuck on the ground while others go up, remember a) there's another ship next month, and b) until the shielding is up, the bitter wind of a solar flare can blow out their candles.

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*See "Far Out Crime," **L-5 News,** Sept. 1978

That's Lazerus Long Quotient, see page 265 — page 248 paperback — in **Time Enough for Love by L-5 Director Robert A. Heinlein.

Government Rip-Off?

Were the 1978 Solar Energy Policy Forums merely misrepresentations that swindled taxpayers out of millions of dollars?

Why was testimony concerning SPS ignored in the government summaries of the forums?

Why the huge discrepencies in the attendance reported in government statistics and attendance counted by eyewitnesses?

Why did the "broad spectrum" of public opinion reported by the government turn out to mainly include those who favor decentralization and "do-it-yourself" renewable energy systems?

By Jennifer Atkins

On Sun Day, May 3, 1978, President Carter announced a Domestic Policy Review of Solar Energy. The goals of this review sounded promising: to analyze the contributions solar energy can make, to review current solar problems, and to recommend a strategy to pull together the efforts of private, Federal, and state sectors.

Dept. of Energy (DOE) Secretary James R. Schlesinger, Chairman of the Review, sponsored a series of eleven forums in order to receive comments on solar energy from a broad spectrum of the public. Transcripts of these forums are being assimilated and presented for the President's consideration. We at L-5 are seriously questioning the processes used to set up these forums, and we have reason to believe that the official results of the hearings contain unexplained inaccuracies.

A Stacked Deck

These hearings were the responsibility of the Department of Energy. They contracted out the publicity and reporting of the hearing to the Franklin Institute. We believe the publicity was designed to attract only a portion of the spectrum of those interested in solar energy. In particular, the bias was towards those with anti-technology, pro-decentralization preferences.

Mailing lists were used to give people advance notice of the forums and registration cards for scheduling speakers. Instead of using primarily their own mailing lists, DOE used lists provided by the National Solar Heating and Cooling Information Center and the Institute for Local Self Reliance.

The National Solar Heating and Cooling Information Center provides information on primarily domestic commercial solar heating and cooling systems. It does not have any information on large scale solar energy systems. Their mailing list is derived from individuals, groups, and small manufacturers who are interested in "soft technology" solar energy systems. Approximately 300,000 names came from this source.

The Institute for Local Self Reliance provided 100,000 to 200,000 names. Although these names reflect a broader spectrum of interests in solar energy, the majority of views is in favor of the do-it-yourself renewable energy systems.

To these two mailing lists, DOE added 5-10% more names from their own lists of businesses, universities, unions and other small special divisions.

These mailing lists do not represent a broad spectrum of the public interest in solar energy but rather a very narrow focus of opinions. This is also true concerning the groups sub-contracted to assist regional DOE offices. The Franklin Institute, of which the National Solar Heating and Cooling Information Center is a part, was contracted to handle most of the logistics of the forums. Also, the Institute for Local Self Reliance was given a contract to provide aid to the regional DOE offices in the form of recommending "appropriate" speakers for the forums. They sub-contracted this to local groups that included the New Roots group in Boston, a group that favors "decentralized, low-technology, community-controlled solar energy," and the Cascadia Regional Library in Eugene, Oregon, an environmental group.

The Hearings

The hearings of each region were summarized in 10 reports. The **Consumer Briefing Summary** #7 gives brief summaries of each of the 10 regional hearings and summarizes the July 13 Washington hearing. The Franklin Institute and its subcontractor, the Institute for Local Self-Reliance, prepared another report under a DOE contract, entitled **The Great Adventure**, dated October, 1978. The hearings are also summarized in the recently completed movie, "Solar Energy — The Great Adventure." We have reason to believe that the reports of the hearings are inaccurate.

Hearing Attendance?

The **Consumer Briefing Summary** states that 10,000 people attended the hearings. **The Great Adventure** states that 2,500 attended the Boston meeting, stating, "We may roughly conclude that between 7,500 and 20,000 people came to listen or ask questions." We looked at the Region 1 **Summary Report** of their hearing, and sure enough, they estimate over 2,600 attendees. However, a group of six solar power enthusiasts who were handing out solar power satellite literature at Faneuil Hall (site of the hearing) report that the vast majority of the head count was due to the vacationing families visiting the historic building.

An observer for the American Institute of Aeronautics and Astronautics reported 50 people in the New York City hearing room. The Region 3 report gives a head count of 200. Gordon Woodcock, who testified at the Seattle hearing, reports 25 in the room. Our estimate of total hearing attendance is around 2,000.

SPS Testimony Ignored

The Great Adventure states that about 1,350 people testified. The **Consumer Briefing Summary** insists that 3,000 testified. Testimony covering solar power satellites was ignored in the statistical breakdown in **The Great Adventure.** This is not because there wasn't enough testimony to warrant inclusion. We are aware of at least 12 oral presentations entirely supporting power satellites, and one in opposition. While this is ignored in the statistical breakdown, the 10 who covered solar thermal electric, the 8 who discussed ocean thermal and the three who touched on industrial process heat were represented.

What happened to the solar power satellite testimony? For example, in the Boston hearing four of those presenting oral testimony covered the favorable aspects of SPS and one opposed it. This represented nearly 10% of those giving oral testimony. However, only 1% of the summary of oral testimony covered the subject. The **Consumer Briefing Summary** contains three very brief references to SPS, all negative. **The Great Adventure** has no references to SPS.

Conclusions of Hearings.

After first stacking the deck by selective publicity and then by eliminating testimony that didn't fit the Franklin Institute/Institute for Local Self-Reliance mold, their conclusions are not surprising. "The support for solar energy was far less a response to the energy crisis or the need for a switch from nonrenewable to renewable energy resources than it was a reaction to the scale of institutions in America." "Stop laboring under the impression that energy is a technical problem. It is not. It's a social problem." "The dominant theme of every hearing was strong support for the decentralizing and self-reliant characteristics of solar energy."

ACTOR EDDIE ALBERT, well known for his television and film roles, is narrator for the new DOE film "Solar Energy–The Great Adventure." Shown with Albert in the recording studio is Joe Carvajal of DOE's Office of Consumer Affairs, production coordinator for the film which will be released in a few weeks. The film features alternate energy "pioneers," who presented testimony at the Domestic Policy Review's Series of public meetings on solar energy, at work in various locales around the country. (DOE Photo by Owen)

Notes on the "Great Adventure" Movie

by Ken McCormick

The DOE has just completed a movie, "Solar Energy — The Great Adventure," which is supposed to report on the solar energy hearings. Consumer Affairs claims not to know at this point how the film will be distributed, but I am told that it will at the very least be sent to all local consumer affairs officers to be loaned out to whomever should request it. It may also go to a commercial distributor. Hobson & Holmberg of DOE say they already have so many requests for it that they don't know how they will handle them all.

The film opens with a recounting of how President Carter called for the Domestic Policy Review of Solar Energy (DPR) and how 3,000 people testified and 10,000 people participated.

Some of the participants then state their views for the camera. One participant says that the point of this whole thing is to be self-sufficient and to get away from big systems that we can't control. Nobody in the film says anything that would tend to contradict this point of view.

Eddie Albert says that people may disagree on when it may be done or how to do it, but they agree that solar energy will happen. He goes on to say that entrepreneurs can do it themselves and backyard "tinkerers" can do it themselves.

Now the film examines specific instances of solar energy being used today by DPR participants. First, we look at what appears to be an apartment complex called Ventura del Sol. The builders couldn't get help from the government to build it, so they did it all themselves. In doing so, they created new jobs. The camera focuses on some long-haired guys and it is explained that these fellows were unemployed before they came to work building this simple solar energy equipment.

The next solar example is a man named Peter Sardana, who finances solar homes. He explains that solar energy hasn't been able to compete very well with fuels that are subsidized by the government. Solar energy is just now crossing the financial threshold, he says.

Eddie Albert explains that solar energy means "people doing things on their own."

We visit an Institute for Local Self Reliance-type group in NYC which provides energy-related assistance to low income people. We are told that a wind turbine will aerate compost which will be used on vacant lot vegetable gardens. We are told that this is an example of "appropriate technology." We are shown a mural pained by neighborhood teens and are told that this solar project has brought them together and aroused their interest in doing constructive things.

Eddie Albert remarks with obvious awe that these people are pioneers.

We are shown a hydroponic greenhouse in San Bernardino, where black people are finally making good with the help of solar energy. It has provided jobs for them.

Eddie Albert tells us that there are industrial counterparts to these just plain folks, and that they are just itching to get going on solar energy. Beautiful scenes of the American countryside stir us to a patriotic fervor as Eddie Albert repeats the half-truths that jobs are created by this new industry — that with this form of energy, small backyard inventors and small businessmen finally have a shot at the American dream — that the government will encourage comunities to small-scale decentralized energy (Eddie emphasizes the word "decentralized") — that decentralized energy is by nature community-based — that decentralized energy will minimize damage by foreign interference or natural disaster.

Oh, yes. For more information, we are urged to write to: "The Great Adventure," U.S. Dept. of Energy, Technical Information Center, Oak Ridge, Tenn. 37830.

The DOE has also recently proposed making a film on solar power satellites which we are eager to see realized.

Space Shuttle Club of Japan

by Iwao Eto

The Space Shuttle Tomo-no-kai (Space Shuttle Club of Japan) was formed last December in Tokyo. The purpose of SSCJ is to enlighten people about the new space era, represented by the Space Shuttle.

The first meeting was held on December 16, 1978 with some eighty people attending, including the press. Jitsuo Kusaka, the famous space and science journalist and the president of the Japanese Astronautical Society, was named president of SSCJ.

The membership fee is 3500 yen (about $18), and members receive a badge, a guidebook, and a reservation ticket for a future Space Shuttle seat (which also acts as a membership card).

The address of SSCJ is:

4-23-8,
Nakaochiai,
Shinjuku-ku
Tokyo, 161, JAPAN

President Kusaka explains Shuttle workings at the first meeting of SSCJ.

DOE Moves Powersats to Front Burner

$8 million in '80?

People often slip into thinking of government agencies as single integrated entities that act with one purpose and one mind. Then it's easy to become confused when these agencies take actions that seem to contradict themselves. Just in case this happens to you after reading the "Government Rip-Off" article earlier in this issue and then the following article "DOE Moves Powersats to Front Burner," here is a reminder: DOE is staffed by many different people with just as many different ideas on how things should be done. From the different moves that we've seen DOE take regarding SPS, we can safely conclude that there is much disagreement within the department on this topic. —JA

by Carolyn Henson

Just last spring the U. S. Department of Energy (DOE) was planning to hold solar power satellite expenditures to $4.6 million in 1979 and pare them down to $3.4 million in 1980. However, the dread Office of Management and Budget (OMB), those penny pinchers of the White House, recently surprised Congress with a 1980 powersat budget of $8 million.

Why, in spite of demands for spending cutbacks, did the White House decide to pump money into the power satellite program? DOE insiders say the answer is simple: there's real promise in the scheme.

DOE is also warming up to some of the more exotic powersat options. They are studying laser energy transmission and are considering the use of extraterrestrial resources for space manufacture of powersat components.

Over in NASA a study on the use of Moon mines as a source of powersat raw materials (see "Lunar Resources Study Underway," **L-5 News**, May 1978) is nearly completed. Its tentative conclusion is that Moon mines make sense if you build enough powersats. The issue to be resolved is simply whether 5 or 50 or 500 are "enough". If the answer is closer to 5, then Moon mines, space factories and orbiting cities would be built early in a powersat construction program.

Of course, OMB approval of a stepped-up powersat program isn't quite the same as money already in the bank. But given the vociferous support of people such as Representatives Fuqua and Flippo and Senators Stevenson, Melcher, Schmitt, and Goldwater, it's a cinch that Congress will O.K. the White House call for an expanded solar power satellite program.

Space Policy

Scientists, politicians and industry representatives objected to Carter's space policy in Senate hearings.

by Ken McCormick

President Carter's space policy came in for some sharp criticism at hearings before the Senate Subcommittee on Science, Technology and Space last January 25, 31, and February 1. Many witnesses offered testimony which expressed the opinion that the present space policy is inadequate to provide a strong sense of direction for business, industry and science.

Corporate Views

A statement from Dr. John L. McLucas, president of Comsat General Corporation, was typical of the concern expressed by representatives of business and industry: "We are now in a fiercely competitive global marketplace in which technology, including space technology, is critical to the nation's competitive posture. Others are competing for leadership in space and for the commercial markets which space will continue to open up. They have made significant advances in the past years.

"In order to meet the challenges of the future in the area of space applications, particularly with respect to the provision of space services, we need to do wherever possible what was done in the Satellite Act (of 1962), namely, (i) establish policy goals; (ii) take decisive action to engage the technical, financial and management resources of the private sector in the establishment and operation of space systems; and (iii) provide for appropriate cooperation and delineation of responsibilities between the private and public sectors in the achievement of these goals. A policy which incorporates these elements with respect to space applications will remove ambiguities and uncertainties which tend to suppress and delay initiatives in space and otherwise undermine the U.S. leadership and commercial position in space.

"Clearly, the decisive policy decisions taken by the Congress in the case of satellite communications, which were largely responsible for the success of satellite communications, are lacking with respect to future space applications. In our view, the Administration's civilian space policy is unclear... as to the role contemplated for the private sector in space applications."

Benefits to the Economy

Mr. Ted Smith of McDonnell Douglas Astronautics characterized "the substantial pool of management, engineering, test, and manufacturing capability that now exists" as representing "a valuable national asset." He went on to say that his company believes that the government "must define long range goals and provide "seed money" in research areas that exhibit high potential in terms of feasibility and utility. This "seed money" can feed back into the economy in many ways; more jobs, improved health, and better living standards, to name a few. The relatively high cost and the associated financial risk of most potential future space products act as deterrents to private industry. It is the low or uncertain probability of a near term return on investment that dampens private industry's enthusiasm for these projects. We believe that for the forseeable future, the government must initiate and support space experiments and pilot facilities for conducting research in Earth orbit. When the capabilities and potential of manufacturing or processing commercial products in space have been established, attractive applications will be exploited by private industry as a matter of course."

Small Business Views

The point of view of the small business community was represented by Gerald R. Seeman, president of Developmental Sciences, Inc.: "A small business doing business in state-of-the-art aerospace technologies offers a team of innovative people capable of rapid response, flexibility, and endless energy. These teams need the opportunity to have a consistent flow of funds through government research, development and prototype contracts with fair profit allowances to stimulate new ideas and to maintain the team continuity and its morale. It's here where the majority of this nation's products of tomorrow will germinate. Small business needs a National Space Policy Act in order to reasonably anticipate a market for our talents."

Dr. Seemans also expressed a preference for Senator Harrison Schmitt's space policy bill, and said he felt that space colonization was an option that must be considered.

Scientific Returns

The president of the National Academy of Sciences, Dr. Phillip Handler, complained that last-minute funding decisions on missions of space exploration were resulting in scientific returns that are far smaller than those that could be achieved with adequate long-range preparation. "We are doubtful," said Dr. Handler, "that a coherent program can survive without a formal national, long-term commitment; in the absence of such commitment, if decisions were to be taken sporadically, each considered within the context of a single annual budget cycle, the losses to science could be substantial and of national proportions." Dr. Handler went on to say that the legislation on space policy introduced by Senators Adlai Stevenson III and Harrison Schmitt would foster and protect a sense of commitment.

Press, Stevenson, and Schmitt Debate

As spokesmen for the Administration, NASA Administrator Robert Frosch and presidential science advisor Frank Press defended the space policy put forward by Jimmy Carter, describing it as "vigorous" and as providing a "positive source of direction." "The era of 'one-shot spectaculars' is over," said Dr. Press, "and the space program will now proceed in an 'evolutionary' manner."

Dr. Press said that space policy must be sensitive to the "new realities of economic and fiscal policy that must govern the nation in the 1980's." The forseeable national economy and existing priorities "clearly dictate that we make choices," said Press. As resources and manpower requirements for Shuttle development phase down, he said, we will have the "flexibility" to increase or decrease space funding levels.

Senators Adlai Stevenson (D-IL) and Harrison Schmitt (R-NM) debated press on the relative merits of their own space policy bills vis-a-vis the Carter Space Policy.

Stevenson: I sense that this Administration's objective is reorganization, study and restudy, and that is one of the reasons it is such a small achiever. Let me cite, for example, your points about the Administration policy and my own bill, which establishes a space policy. You say it's the Administration's policy not to commit to future programmatic activities without first undertaking necessary evolutionary research and development steps.

Now research and development doesn't occur in a vacuum; it occurs in the pursuit of some objective. Why not begin to establish the objectives of our space policy, the next steps, and the capabilities that we are going to need, instead of continuing through interagency reviews and reorganizations and research and development? What is wrong with setting out some near-term objectives? Doesn't such an approach give us in our annual budgetary considerations an opportunity to consider the budget in something other than a vacuum?

And I notice also you say, priorities should be set, depending on the promise of the science and technology available, which I'm suggesting to you won't be available in the budget situation at a given time.

Why is it the budget must always run the government? Why don't we decide what to do and let that determine what the budget will be? I sense also that OMB (Office of Management and Budget) is driving the President. It's driving the country, instead of the other way around.

Press: That's precisely what we thought we were doing in setting out our civil space program. We laid out a framework; we laid out our goals so that space policy would not develop as part of an annual budgetary process. That procedure worked this year because, in going through the space budget and going through its projections for the out years, we used precisely the civil space program decisions of the President in setting the priorities, in making sure the NASA budget in this very tight year was protected to the greatest extent possible.

We believe we have the framework, we have the goals that you want us to have, and that this will be a main part of our budgetary procedures.

Stevenson: Well, maybe we ought to try to agree, then, on what those goals are and get a little bit more specific. Mine don't lock us into any rigid timetable. They're 10-year objectives, all subject, of course, to annual authorization and appropriation requirements, all subject to being moved by the speed with which we develop the technology and budget considerations.

Schmitt: I can't tell from this (indicating Press's written statement) where this country is headed in space, Dr. Press. You say — and, I think, rightly — that there are a lot of things that we ought to do in applications and communications and weather forecasting, public-service satellites. That's true, but that's what we *already* can do. That policy direction was set years ago. Beyond that, policy which has already been set by the past, there's nothing in here. This isn't a policy statement.

You make reference in here to "we're getting away from the era of one-shot spectaculars." What "one-shot spectaculars?" The Apollo program was a series of missions. It had one specific goal when it started: put a man on the Moon and return him safely to Earth. But it became a program, not a "one-shot spectacular." The exploration of the Moon in the first cut was accomplished by the Apollo program.

Skylab was not a "one-shot spectacular." It developed through three missions a broad understanding, a knowledge of what the new environment of near-Earth space can provide — the weightlessness, the high vacuum and high pumping rate, the view of the Earth, the Sun, and the stars.

We now know what we can do if we're just willing to commit to some kind of direction, and that's what I don't see in this policy, and I think that's what Senator Stevenson in his way and I in mine are trying to get out of the Administration: some sense of direction. Right now the people who are going to have to carry out a space policy won't get

Senators Schmitt and Stevenson at the Senate Subcommittee hearings.
(photo courtesy of Charles Divine)

Schmitt: "What we are missing is the policy for the future."
(photo courtesy of Charles Divine)

anything out of this document other than a statement "we're going to continue to look at it and then maybe someday we'll make some decisions." This country can't afford to tread water much longer on this particular issue.

Press: Senator, we believe we have a program outlined for space sciences exploration and application in the years ahead which will return to the American public major dividends on the investments of some hundred billion dollars over the years, which is a realistic program in terms of the country's fiscal state, and which will maintain leadership of this nation in space.

Schmitt: The return on that investment of a hundred billion dollars is every day around us. And if somebody could just figure out how to calculate it, the return is probably close to a trillion dollars, just in the period of time we've had that investment before us.

The Administration's implication is that we've gotten nothing out of the space investment. The President implied it in his speech at Kennedy. You've implied it here in this. And I have seen it in print other ways, from administrative statements. The thought expressed again and again in these statements is that somehow or another technology is not an investment, that it's something added on to the budget, whether it's space or energy or something else, and that we get nothing from that.

It is the only thing that this government can invest in that is deflationary, inherently deflationary. It creates new goods and services. So, what we're getting is, I think, a lot of economic dogma about space and about technology out of the Adminstration that is going to make it very difficult for the Congress to come to any decision. What this country needs is a rejuvenation of our inherent American willingness to create new things.

Press: I don't want to argue with you on the basis of your economics. I agree with you that we have received major dividends in the past, and that we will receive many more in the future.

One of the President's major tools in fighting inflation is control of the expenditures of the Federal Government, and that's why he submitted this very tight budget. Despite those restraints, these programs which we have committed to will go on, will continue, and we have room for even additional programs in these areas. The President's research proposal this year will bring research support by the Federal Government to an all-time peak in deflated dollars. Why has he done this? Because he agrees with you that research, that science and technology is a tremendous investment for this country to make, and he is undertaking to do that.

Schmitt: Dr. Press, we heard some similar statements like that in the last budget, of increases in basic research funding. But when it came down to how much the Administration really wanted those things, we didn't see a great deal of lobbying activity here on the Hill to protect those requests. I hope that we will see more intense activity to back up the statements that you have just made here in the Congress than we saw last year. I also hope that we can get away from this feeling that somehow or another, when there's a deficit, that all expenditures are equivalent in their inflationary impact. They are not. That is just economic lunacy.

Now, all of those things that you described that you say are protected in this year's budget and have been protected by the Administration are, again, representative of policies that were established years ago. Those aren't policies; those are the implementations of policies. The fact is, I would like to see those policies implemented further. I think everybody would.

What we are missing is the policy for the future. All that is in this statement that we have had today and that we've heard from the President is a discussion of how you are going to continue to implement past policies, and I don't call that a policy.

Quiet Colony

Buzz! Grate! Chugachuga! Wheeze! Grind! Bark, bark, bark! Honk! Roar!

Will space colonies be built with the acoustic environment of a New York subway? Although we joke about the racket of day-to-day life, there is evidence that it damages our hearing, health and peace of mind. And at least one person is already considering how to design space colonies that will sound as restful as a morning in the countryside. He's Robert Alex Baron of Citizens for a Quieter City, and he hopes to hear from others who share his interests. He can be reached at P.O. Box 796, Ansonia Station, New York, NY 10023.

*The following two pages may be copied and used for membership forms.

The New Space Program

by Philip K. Chapman

I encourage you to become more deeply involved in the national debate over the goals of the space program and its relevance to the present predicament of humankind.

I have given much thought to this subject, both while I was a scientist/astronaut and since leaving NASA, and I am convinced that our society must give a high priority to establishing industry off Earth, and then to permanent and growing settlements in space.

A movement is underway, in America and around the world, a movement of people who share these convictions. We need your ideas and your help.

A Turning Point

Even the opponents of the space program agree that we have arrived at one of the most crucial turning points in history: what we do, or fail to do, during the next few years can determine the fate of humanity for centuries to come.

If we choose challenge and achievement, the path which leads us out into the solar system, we can be pioneers in an unmatched era of physical, intellectual and cultural growth. But if we choose regression to a simpler life-style, we shall instead condemn our descendents to a deepening spiral of poverty and alienation and conflict in a dirty, crowded and decaying world.

The awesome choice is ours, and may not be postponed, for we must act while we in the advanced nations still retain a slim surplus of resources. If we do not create in our time a truly spacefaring society, then the opportunity may be lost in the grim turmoil which will mark the beginning of the new Dark Ages.

The Haves and the Have-Nots

The dilemma we face is simply stated. The appalling gap between the rich and the poor peoples of the world has finally become intolerable, not only because of the awakening conscience of the affluent nations, but because the majority who live in conditions of brutal misery are no longer resigned to their fate.

Demands for equity are rapidly becoming more belligerent. The problem is that the revolution of rising expectations has coincided with the realization that this little planet cannot long supply the resources to maintain an acceptable standard of living even for those who now enjoy it, and that the planetary environment cannot long absorb the damage from sustained industrial growth.

Conservation vs. Growth

There are many now who will tell you that small is beautiful, that the problem can be solved if the greedy rich, and especially we Americans, will cut back consumption and adopt lives of voluntary simplicity, guided by the virtues of frugality and self-sufficiency.

In this view, our problems are a punishment for technological hubris, and we must recant if we are to be saved. Thus, it is a semi-religious prescripton for the reformation of man rather than a practical policy to aid the starving in Asia and Africa.

True, our society has been wasteful in many ways and more careful husbandry of nature could actually improve our lives—but those who claim that major economic growth is unnecessary are either victims of illusion, denying simple arithmetic, or more interested in promoting idealogical causes than in dealing with the crisis.

One statistic should be sufficient: the gross world product per capita is about $900 per year, a factor of seven below U.S. levels. If we could distribute the world product more evenly, could you survive on one seventh of your present income?

Moreover, world population will inexorably double over the next several decades, with almost all the increase in the less developed countries. It should be clear that there are far too many poor for any practical redistribution of wealth to be more than a futile gesture, whatever the ethical merits of such a program might be. However, the move towards social equity easily can and probably will erode the economic surplus of the affluent, thereby precluding the development of real solutions.

The Space Frontier

The human prospect is indeed bleak if expansion is impossible, if we must be limited to the terrestrial zero-sum game. Fortunately, space technology has advanced to the point where we can assert with confidence that this is not so.

There is no longer any doubt that the solar system is rich in energy, minerals and other resources, and only the adamantly uninformed can cling to the idea that they are inaccessible to us. The knowledgeable consensus is that the development of space resources is clearly technically feasible, but that it must be undertaken on a large scale in order to be economically justified.

With sufficient traffic to orbit, the costs of spaceflight can be reduced to levels comparable to airline operational costs. The complex of proposed projects now known as the New Space Program (which includes direct-broadcast television satellites, solar power satellites to end the energy crisis, permanent research facilities and factories in Earth orbit, lunar and asteroidal mining and long-term space habitation) can provide ample motivation for building a cheap space freighter.

The problem is that the initial funding needed for space industrialization is large by the standards of the private venture capital market. By Government standards, however, the funding level needed is quite modest, about equal to the receipts from cigarette taxes.

The New Space Program is the only viable means I know for sustaining economic growth indefinitely, which in turn provides the only hope that some day people everywhere may be fed and clothed and housed.

The immediate benefits from investment in such a program can include slowing of inflation, improvement in the

U.S. balance of payments, provision of exciting and meaningful jobs, and liberation of the human spirit from the defeatism now so prevalent.

In view of the promise, it is quite remarkable that these, the truly important uses of space, are currently receiving directly less than one percent of the NASA budget; and the whole NASA budget is less than one percent of the overall federal budget. I think these figures speak for themselves.

What You Can Do

If you agree with me about the significance of the New Space Program, if you would like to help get it moving, or if you just want to find out more about it, I have three suggestions for you:

1. Write to your representatives in Washington and urge them to support a vigorous, balanced, ambitious and well-funded space program.

2. Send me a postcard at the L-5 address telling me if you agree that expansion into space needs a much higher priority in our society. Feedback about these ideas is very helpful in itself and also because of its possible political impact.

3. Join the L-5 Society. This is a small but growing organization (there are over 3,000 members worldwide) which includes engineers, scientists, authors, members of Congress, business leaders and people from all walks of life. They are joined together by dedication to the proposition that our civilization must be allowed to grow, by rapid expansion into space, or else it will die.

I hope you will join with me, with Isaac Asimov and Robert Heinlein, with Senator Barry Goldwater and the other members of the society in direct participation in this, the most inspiring and significant venture of our time, or, perhaps, of any time in human history.

Life Support Workshop

By John M. Phillips,
Arizona Research Associates, Inc.

In early January, a workshop was held at NASA Ames Research Center which was concerned with the eventual need for life support system technology for large-scale, long-duration space missions. Entitled "Guiding the Development of Controlled Ecological Life Support Systems," the meeting focused on the need for a ground-based demonstrator facility to test such problems as ecosystem closure, food regeneration from wastes, and system safety, reliability and predictability.

Forty prominent scientists were assembled by workshop organizer, Dr. John Carden of the Georgia Institute of Technology, for three days of intensive deliberation. The participants were divided into six groups: human nutrition and food processing, food production, ecology, systems engineering and modeling, waste-processing, and a NASA overview group.

Each group was asked to consider the relevance of the ground-based demonstrator as a research tool for its discipline area. A consensus rapidly emerged that the demonstrator was a logcial milestone in the development of life support systems for large space habitats. Ground-based research was judged more economical than going directly to experimentation in the space environment. Furthermore, the results of research in a ground-based facility could be applied readily to terrestrial problems.

Indeed, many of the experts pointed to the need for research of the kind required both to solve the life support problem for space travel and to address issues of major concern to science and society today. Intensive food production, recycling of wastes, pollution monitoring and control, and the development of controlled ecosystem technology for human life support were among topics discussed as being highly relevant to the present needs of society and deserving of support for their terrestrial applications and benefits.

The possibility was raised that NASA may be able to work with other agencies which have a mandate to study and support research in some of these topic areas. If such liasons could be developed, concerted effort could be brought to bear on the problem of the requirements for human life support.

This research question promises to be one of the most classical problems ever confronted by the scientific community and one that may emerge as a crucial study to ensure a meaningful future for human society.

The results of the Ames workshop on life support systems will be published shortly as a NASA technical memorandum which will summarize the research and technology development recommendations of the participants. Congratulations for an excellent and productive workshop are due the workshop organizers, John Carden, Bob and Betty Mason of Metrics, Inc. of Atlanta. Dr. Spurlock of the Georgia Institute of Technology served as the workshop chairman and led the workshop admirably.

It was my pleasure to have worked with these individuals as leader of the food production group. Additional details concerning the workshop's conclusions and recommendations will be provided in an article at a later date.

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L-5 Society
1620 North Park Avenue
Tucson, AZ 85719

SKYLAB

By Jennifer Atkins

Here it comes! A frightening 80 tons worth of spacecraft is getting ready to crash through the Earth's atmosphere. At $2.5 billion, it will be the most expensive light show ever. But will that be all?

Experts say that when Skylab reenters the atmosphere red-hot chunks of debris up to two tons in weight could survive to hit the ground. They would be traveling at a speed of around 2,000 feet per second—not much slower than the velocity of a rifle bullet leaving the barrel.

And what does NASA say? Officials from the space agency are emphasizing that the odds of being hit by defunct space program hardware are less than those of being hit by a meteorite. Plus, Skylab spends 75 percent of its orbit over the oceans, which further reduces the possibility of it hitting any people. However, when it is not over water, Skylab flies over some of the most densely populated areas on Earth.

What Could Be Done?

The North American Interplanetary Society, a non-profit space oriented group based in Victoria, B.C., Canada, has launched a worldwide "Save Skylab" campaign. The campaign involves getting cooperation between the United States, the Soviet Union, and the United Nations for an international rescue effort.

The Soviets could boost Skylab into a higher orbit, using a Soyuz craft to rendevous with Skylab. The docking would be no problem, thanks to the international docking adapter developed for the Apollo-Soyuz Project in July, 1975. The Soyuz craft, which normally rendezvous on a transponder, could be guided by mission control in Houston.

The North American Interplanetary Society proposes that the United States donate Skylab to the United Nations while the Soviets contribute their Soyuz and booster. When the rescue is accomplished, the United Nations would have moved into the realm of International Space with the acquisition of a habitable space platform, available for the use and benefit of all peoples of the world.

The Canadian government is being asked to forgive the $6 million Cosmos 954 clean-up bill to the Soviet Union in return for Soviet participation in the rescue. The cancelled bill would be Canada's contribution to the campaign.

U.S. Cooperation

Angered at Soviet human rights violations, the Carter administration has opposed any activities (such as the Skylab rescue) which would allow the Soviets to obtain new technology from us. Also definitely a factor is the humiliation that our government thinks the nation would suffer having the Soviets bail out the number one space power in the world.

These attitudes help explain the difference of opinions at NASA. High-echelon officials at the space agency have publicly announced that the Soyuz-Skylab rescue is not technically possible. However, lower-echelon employees at NASA, who are actually closer to the project, declare privately that the endeavor is perfectly feasible.

And so it goes. The people who could save Skylab seem to be just keeping their fingers crossed and saying that it *probably* won't hurt anything. As the space age becomes a reality, a precedent of international cooperation for emergency rescues would be an important asset. This type situation will inevitably reoccur. Unfortunately, it seems to take a disaster before people will begin to prepare for inevitable problems.

Apollo Commander Tom Stafford and Soyuz Commander Aleksey Leonov in the docking module during the 1975 rendezvous. This docking adapter could make possible a Soyuz rescue of Skylab.

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NOTE: 1. 1-3 page Executive Summaries of any document can be ordered for $1.50 each.
2. Microfiche copies are on 4″x6″ diazo microfiche only.

Send *check* or *money order* to:

PASSIM Company, 3102 Beauchamp Street, Houston, Texas 77009.

International Satellite Industries, Inc. Launched

by Carolyn Henson

"I'm the President of Skydoggle, Inc. We're gonna build solar power satellites out of soda straws. Can you folks tell us who's working on that stuff, and where we can get some money?"

"My brother's wife and I have created the C.O.S.M.O.S. Foundation. We plan to build the first space cemetery. Send your contribution today! You are encouraged to leave a generous bequest in your will."

These are only slightly fictionalized versions of the letters and phone calls the L-5 Society has received from people who range from the merely naive to the frankly larcenous. Needless to say, you never hear of them in the **L-5 News.**

However, Christian O. Basler and the staging company concept are not strangers to these pages. (See "Do You Sincerely Want to Become Rich," **L-5 News**, Dec. '77.) So we greeted with delight the news that International Satellite Industries, Inc. (ISI) filed a registration statement on March 5, 1979 with the Securities and Exchange Commission. That means we can finally report on ISI's progress without incurring the Securities and Exchange Commission's wrath!

ISI started out as a purely academic idea. Christian O. Basler, a lawyer formerly with Western Electric, presented a paper on the staging company concept at the Industrialization of Space Conference in San Francisco in Oct. 1977. Encouraged by the response he got, Basler incorporated ISI last August and plans to be selling stock by this July.

According to its prospectus, ISI intends nothing less than "...eventually to construct and sell solar power satellites..."

Why does ISI rush in where the big aerospace companies fear to tread? First, the "rush" may well be 20 years. Secondly, as a staging company ISI first accumulates capital by investing the money it receives from sales of its stock. Only the dividends and interest from its investments will be spent on power satellite reasearch and development.

When the ISI feels it has enough of a handle on the task to make a profit building powersats, it will convert to an operating company. ISI will liquidate its investment portfolio and take out loans as needed and pour the money into construction.

That assumes, of course, that a myriad of pitfalls can be avoided. What if powersat electricity can't compete? If the vast amounts of money can't be raised? What if the U. S. or another government or another private company start to build solar power satellites first? The fallback position, if things look hopeless, is to liquidate ISI and distribute the assets to the stockholders. Due to the financially conservative nature of an investment company, the odds are fairly good the disappointed stockholders would get back most of what they put in.

Stock in ISI is not for those who need a dividend income. ISI has no intentions of declaring dividends until some years after it becomes an operating company.

However, the adventurous may take an interest in a section of the ISI prospectus reading "...the Company may give preference in its hiring of space workers to holders of the Company's Common Stock."

The address of ISI is:

Christian O. Basler
ISI
250 W. 94th St.
New York, N.Y. 10025

Who's Behind ISI?

Who are the people who put together International Satellite Industries, Inc.? Foremost is ISI President Christian O. Basler, formerly a lawyer for Western Electric, Basler is also a member of the ISI Board of Directors.

The other ISI directors are:

Philip K. Chapman, a former scientist/astronaut; currently he is solar power satellite researcher for Arthur D. Little, Inc.

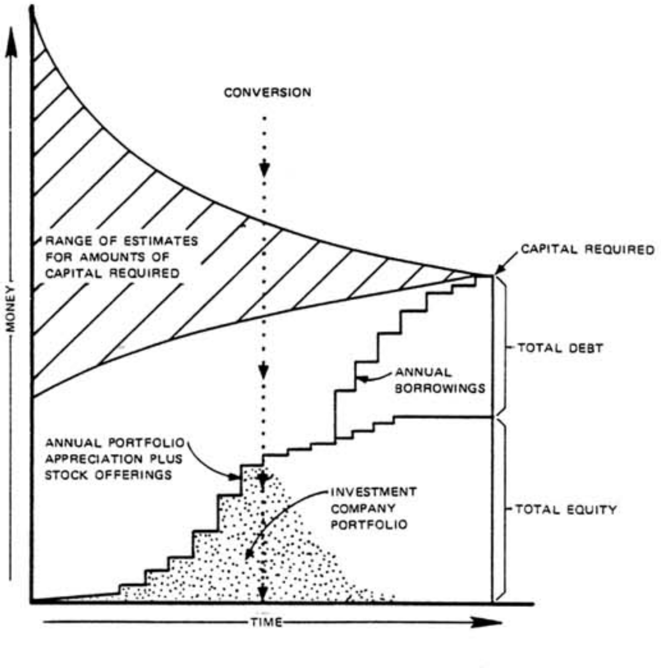
Edward R. Finch, a top international aerospace lawyer.

H. Keith Henson, president of Analog Precision, Inc. and co-founder of the L-5 Society.

Ralph H. Nansen, Manager, Space Solar Power Systems, Ballistic Missiles and Space Division, Boeing Aerospace Co.

Brian T. O'Leary, former scientist/astronaut, currently an extraterrestrial resources researcher at Princeton University.

Edward V. B. Stearns, Program Manager, Space Systems Division, Lockheed Missiles and Space Co., Inc., and Executive Vice President of the American Astronautical Society.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Of Interest:

Register Now for Princeton Conference

by Carolyn Henson

Planning to attend the Princeton Space Manufacturing Conference May 14-17, 1979? According to Barbara Evans of the Space Studies Institute you'd better write in early and give reasons why you should be allowed to attend. Conference space is limited and only the "top applicants" will be able to make it. (Last time they turned away so many people they didn't fill it up.)

To squeeze in, write to:

Bill O'Brian
Princeton Conference Office
5 Ivy Lane
Princeton, N. J. 08540
(609) 452-3371.

If the Princeton people give you thumbs down, don't despair. They have magnanimously provided a session open to the public the morning of May 17. For details, contact the Princeton Conference Office.

Following the public session there will be an afternoon party for Space Studies Institute subscribers. SSI, one of the conference sponsors, can be joined by sending $10 or more to Box 82, Princeton, N. J. 08540. SSI funds research by Princeton physics professor G. K. O'Neill.

If you object to closed conferences, there are several courses of action available.

First, you can ignore the darn things and only patronize open conferences. We will run notices in the **L-5 News** as these conferences come up. Two good ones to watch for are the annual meeting of the American Astronautical Society next fall and the annual meeting of the American Institute of Aeronautics and Astronautics next winter.

Second, you can write to G. K. O'Neill at the Space Studies Institute. O'Neill was responsible for holding two open conferences on space manufacturing before his advisors sold him, in 1977, on the closed conference concept. Perhaps, armed with your letters, he will once again stand up for an open conference.

Errata

We gave the wrong zip code for the Niagara Frontier L-5 Society. The correct address is 40 Kings Trail, Williamsville, New York 14221.

In the January issue we listed the author of *High Justice* as Terry Pournelle. The author is, of course, the well-known author Jerry Pournelle. His book, *High Justice*, is a collection of stories, not a novel.

In the February issue the intrepid L-5er who helped at the AAAS covention is Bob Nichols, not Mike Nichols.

Also in February, the wonderful article entitled "Developing Hardware to Support Life on Long-Term Space Missions" was written by Kay Ebeling. She is Editor of the NASA Johnson Space Center *Roundup*.

L-5 at Lehigh

There is an L-5 Society at Lehigh University which is interested in letting all members of L-5 in the Lehigh Valley know of its existence. We are now compiling an off campus list of people who would like to be informed of our activities. In the next few months we will be having a trip to the National Air & Space Museum, a stop at Goddard Space Center and a trip to a local astronomical observatory. We are also assisting the University's "Humanities Perspectives on Technology" Program with plans to have a space colonization course taught next year. Interested persons should contact the club at the following address:

L-5, c/o Peter Goldie
424 Taylor Street
Bethlehem, PA 18015
(215) 691-6805

Detroit L-5

Greater Detroit Metropolitan area now has its own local chapter of the L-5 Society. We are currently involved in developing a presentation based on the L-5 Slide Show, which we intend to use to popularize the L-5 concept in our area.

We are actively looking for new members.

We can be contacted at: L-5 Society for Space Colonization, c/o B. L. Short, 626 Longford, Rochester, Michigan 48063.

Letters

By now you at L-5 News have probably heard about Dr. John Rather's new SPS proposal: sun-pumped laser powersats. My source is *The Foundation Commercial Space Report* of Nov. 1. In case you don't have the information on hand yet, here is the gist of the new idea.

Sunlight is collected by a mirror and brought to focus on a laser apparatus. The laser is excited by the incoherent sunlight and produces an infrared laser beam. The laser beam is modified and reflected by a second mirror and received on Earth. Optical collectors on the Earth can divert the heat beam directly to boilers in the steam cycle of conventional powerplants. The sun-pumped laser powersat may be small in size and produce about 100 megawatts of energy. Such energy in small concentrated doses from space could be used directly by industrial consumers or small utilities. Because of the small size of the powersat, the benefits of competition among several powersat manufacturers should accrue; massive government support and regulation could be avoided.

The sun-pumped laser powersat has obvious advantages and disadvantages but overall seems preferable to the microwave powersat. Both systems may find a niche in the future scheme of things.

Finally, let me express my opinion that we should make our case with the people, not with the politicians. Most politicians are not leaders but followers; they follow public opinion polls and media hype. I don't want tax money building powersats and federal bureaucracy suffocating space development with regulations. The high frontier is a concept whose time has not only come but is many years overdue. The arguments in its favor are overwhelming. If you can't sell this future full of hope to a world starving for energy and freedom, than you can't sell air conditioners in Florida. Simply raise your voices, humbly but persistently, and you will be heard.

Warren Merkey
Gainesville, Florida

As of January we opened our doors as a new public education center, a growth center, on the ocean at Half Moon Bay, on the coast of the San Francisco Bay Area.

Until this last month, I have been a member of the L-5 Society, and I would like very much to promote awareness of L-5. To do a worthwhile presentation demands the slides, though, which we do not have, and we would like to invite an outside guest speaker to do a public presentation on L-5 which we would publicize.

Could you pass the word to the potential speakers and slide-showers of Northern Calif., that our Center would like to promote such a show? This will be small scale, in that we are a new center, and for such an event will probably only draw from the local area, which is not large, but I anticipate speakers working for the love, not volume, of it.

The admission charge would have to be small, to attract people, and any such charge could be split 50-50 between the speaker and our Center for our arrangement of the event.

Please pass on this offer to whom it may concern.

Thank you.

Jiun
P.O. Box 1058
Half Moon Bay, CA 94019
(415) 726-7159 or 726-7635

I note with satisfaction that James Abourezk did not seek reelection to the senate this year. However righteous he believes himself to be, he may be serving the interests of his country better by relenquishing power. For this I thank him. I hope that his South Dakota home is one day powered by solar energy from space.

Gale M. Smith
Auberry, CA

I hope that you might be able to help me get the word out to people who would be interested in the most fantastic class on Outer Space that has ever been given.

This summer, for the second time, Dr. B.J. Bluth will present her class "Man's Move Up to the High Frontier—The Industrialization and Settlement of Space". It will be given at the California State University, Northridge, Ca. from June 25 to August 3. It is an advanced sociology class and can be taken for credit or audited. The class was from 9:30 to 11:00 daily, and will be again. However, the classes lasted well into the afternoon many times. When Dr. Krafft Ehricke spoke, we had trouble letting him leave at 3:30 to catch his plane. The outstanding speakers were a real "Who's Who in the Space World". I'm sure many of your readers would be interested and appreciate the opportunity to hear about this most outstanding class. Quite a few of us will be attending for the second time.

I've been a happy member of L-5 several years now and really appreciate the way your magazine has grown. I'm enclosing a picture of my license plate. The L-5 euphoria leaves quite a few people a bit confused. However, my future studies students are well aware of the meaning.

Shelley O. Pearson
Coordinator
Mentally Gifted Minor Program
Social Studies Dept.
John F. Kennedy High School
Granada Hills, CA

Our problem in the L-5 Society is that we are unwittingly trying to bludgeon the Congress and the American populace into quickly accepting a massive and expensive SPS concept. This seems to be in the direct opposite direction of current public sentiment which favors of decentralization of energy resources. If we approach this problem with the idea of pushing a much less expensive junk collection and reprocessing plant we could much more easily convince Congress and the public that there could soon be a large and far less expensive buildup of material in orbit, in which to carry on the building of large space structures.

I believe that a combination of satellite reclamation and re-processing, and the subsequent manufacture of an asteroid-capturing mass-driver or ion-powered space tug could be the fastest, easiest, and least expensive way to help solve our energy woes and turn a large profit. If carbonaceous chondrite asteroids could be easily brought back to earth orbit, they could be the ultimate mineral resource.

I think the L-5 Society should avidly go after NASA support for a space junk reclamation and remanufacturing plant.

James Frobein
Salina, Kansas

The American Experimental Spaceflight Association has announced a "Peacestar" small satellite project. The satellite will carry one passive experiment, be about the size of a soda can and weigh about 2 pounds. It may carry a tracking beacon and would be launched "Piggyback" by a large booster. Attempts to arrange payload space on both NASA Space Shuttle and the ESA Ariane launcher are in progress.

The first mission (one of ten planned) is called "Peacestar" since it underscores the community of humanity. It will carry small desk sizes of the flags of all nations and thereby be symbolic of the family of man and the peaceful uses of space.

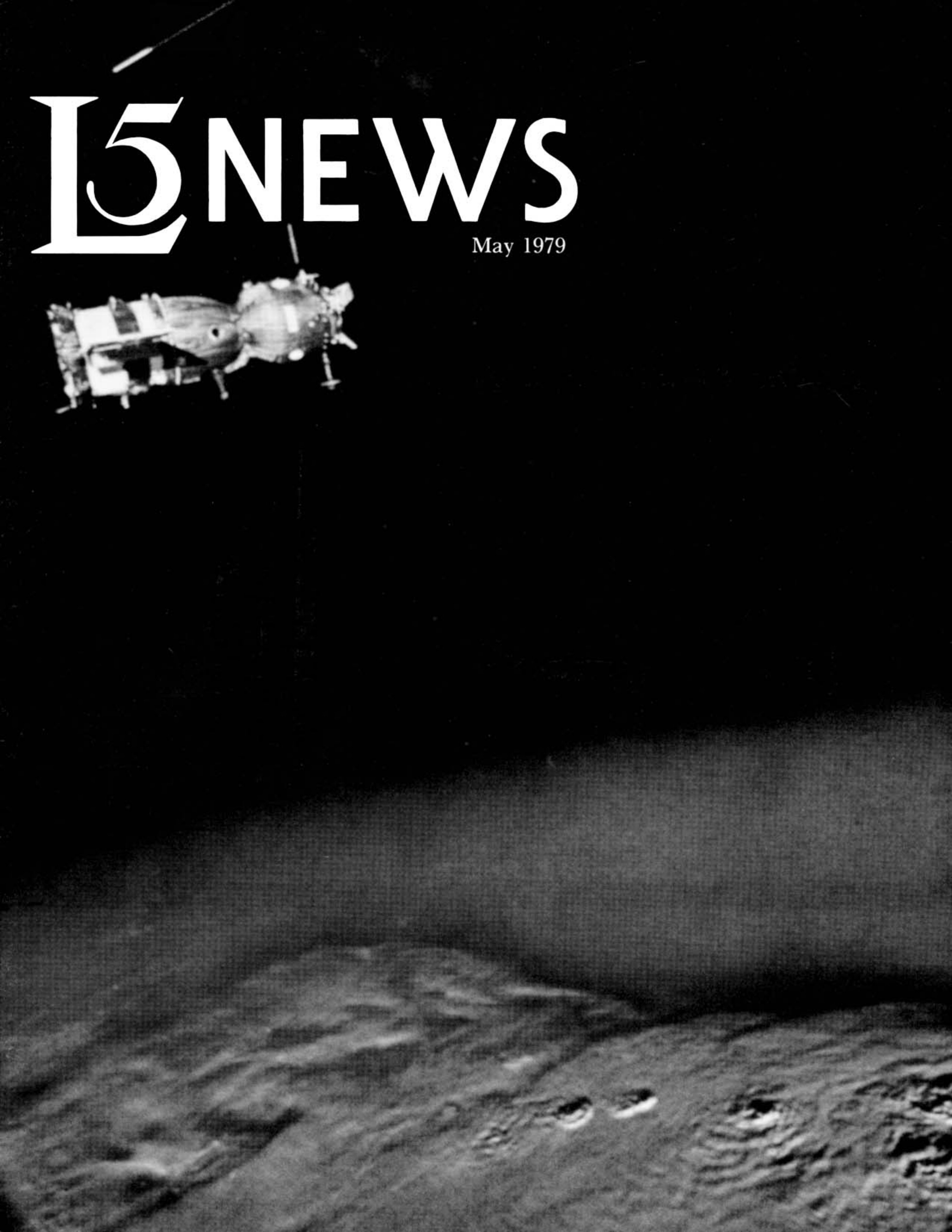
Contributors of $10 or more to the Peacestar project will be placed on the space honor roll to be launched with the satellite. Project director, Paul Geyer, is an L-5 member, a former astronaut candidate and lunar module safety engineer.

Mr. Geyer would be pleased to represent the AESA at conferences and offers a speaker service. Interested persons may contact Paul Geyer, c/o AESA, 230 E. Grand Ave., Rahway, N.J. 07065.

Sincerely,
Paul Geyer

L5 NEWS

May 1979



L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 4 NUMBER 5 MAY 1979

In this issue:

1 **The Useful Pieces of Space** *A thoughtful essay by Eric Drexler on humanity's progress and potentials.*

5 **Breakthrough!** *by Carolyn Henson. Asteroids and solar sails are the answer to obtaining space resources.*

7 **High Performance Solar Sail Concept** *Eric Drexler gives a detailed discussion.*

9 **Reading News**

10 **Salyut-6; Step Towards a Permanent Space Station** *Jim Oberg reveals Soviet advancements.*

11 **More Mystery Soviet Space Tests**

12 **Evolving Shuttle Designs** *by Leonard David. Shuttles for passengers and more.*

14 **News Briefs**

15 **Announcements**

16 **Inside the L-5 Society**

17 **Letters**

Cover: a Soyuz spacecraft (as seen from an Apollo in the Apollo/Soyuz hookup). The recent Soyuz 33 mission failed to dock with the Soviet Salyut Spact station April 10 but safely returned with crew Rukavishnikov and Ivanov 48 hours later. (Photo courtesy **NASA**.)

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THE USEFUL PIECES OF SPACE

by K. Eric Drexler

Less than ten years ago, our next big step in space seemed clear: We had reached the Moon—now on to Mars! But the likely results seemed equally clear: televised pictures of astronauts standing, at great expense, among dusty red crates. Having seen their fill of dusty craters, people simply weren't interested anymore. Aimless, the space program drifted into hibernation.

Today, people are jostling it from slumber. New ideas have revolutionized thinking about the solar system's potential, and have given the drive into space renewed vigor—with scarcely a mention of Mars. Why did we set out for the planets and what has changed?

Behind the awesome achievements of the old space program lay a political choice of goals. Behind this political choice lay not ideas for new industries or a careful quest for new knowledge, but an urge to boast guided by musty preconceived notions. Behind the notions lay history. Ancient history.

Long ago our ancestors lived where it was warm and ate what they could find. Back then, they knew that the secret of wealth was to find something valuable (and unguarded) and to keep it. When they found caves, they lived in them and defended them from others.

The night sky was a dome with a Moon and tiny lights. The Moon and some of the lights moved. This made them more interesting.

Much later, our ancestors leaned many skills. Farming, clothing, shelter, and better and better tools spread them to every corner of the globe and multiplied their number. They now knew that the secret of wealth enough for survival was to have some land and to farm as their parents farmed. The secret of wealth enough to burn was to rule great tracts of land, and to take from those who tilled it.

They called the moving lights gods, told stories, and watched them with care. Time passed.

Tools improved. A few minds escaped a few bonds of the past. Copernicus told us the Earth is a planet; Galileo showed us other planets as globes. As telescopes improved, Mars and Venus drew increasing speculation. People told stories about the planets, now not as gods but as worlds—new lands beyond the sky.

In the freer countries, people with new ideas had produced better tools and organizations, driving the Industrial Revolution. A few people had begun to suspect that the real secret of wealth was neither found things, nor merely land and labor, nor even rule and exploitation, but rather ideas, investment, production, and trade. In all countries, this remained an unpopular idea. Most countries stagnated.

Military competition between rising industrial states led to the ICBM, laying a technical foundation for development of low-orbit information services and reconnaissance systems. One of these industrial states was straining its capacities in an effort to build military strength with German technology: the Russian Empire (alias: "The Union of Soviet Socialist Republics").

The other had its share of German scientists, but was building on a base of real wealth.

During a long period of comparative

> *"Long ago our ancestors lived where it was warm and ate what they could find . . . the night sky was a dome with a Moon and tiny lights."*

Artwork by James Babcock

Artwork by James Babcock

"Having watched record-breaking stunt machines blast around the heavens at their expense for a decade or so, people now knew 'how expensive space is.' "

freedom, U.S. citizens had built the strongest industrial economy on Earth. But by this time, the U.S. government had "found wealth" in the private sector. It took increasing control of slices of economic life, not so much by the socialist pattern of state ownership as by a pattern of taxation, regulation, and market domination. In particular, the government virtually ran the emerging aerospace industry.

Consequently, the government's whims ruled our first steps towards space: rather than begin to explore and use space with existing ICBM boosters, the government decided to develop a "civilian" booster for purely symbolic reasons. In the delay, the Soviets beat us into space, badly wounding government pride. The stage was set for the great leap forward.

To heal its wounded pride, the government decided to indulge in an economically and strategically irrational whim—to land a citizen on the biggest thing in the night sky and bring him back again. It pursued this goal in the style of state-backed bureaucracies the world over: with no concern for making profits, little concern for cutting costs, and much concern for cutting the risk of embarassing failures. (This style has been estimated to multiply costs by a factor of about three.) The safe bet for reaching the Moon in a hurry was to scale up and extend the throw-away rocket technology of the ICBM, bypassing space stations and shuttles. This took wealth enough to burn, but the government ruled great tracts of land...

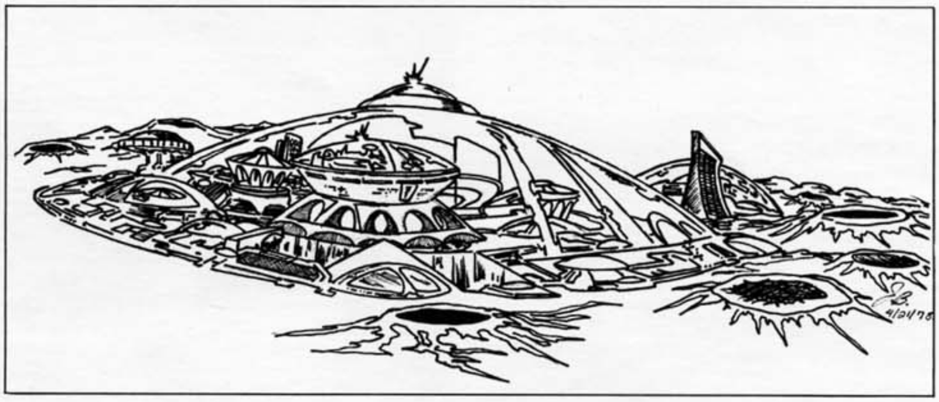
Thus America reached out, touched the Moon, satisfied the whim, and quit. Having watched record-breaking stunt machines blast around the heavens at their expense for a decade or so, people now knew "how expensive space is."

In parallel, and with a similar lack of economic motivation, the government decided to take a close look at the moving lights in the sky. In the public mind, the planets were seen as interesting because, like Earth, they had lands with sights to see, and because they too might someday serve as homes for humanity. Had Mars been more Earthlike, or alive, rather than pocked, dusty, and dead, or had Venus been wrapped in desert and jungle, rather than searing, high-pressure carbon dioxide and sulfuric acid, then the public might have kept its enthusiasm.

As it was, public interest in the planets collapsed to a tourist's curiosity about distant wastelands. Spaceflight offered an expensive ticket to nowhere.

Renewed interest in space arises from new ideas about its value. Central to this has been a turning away from searches for the "found wealth" of habitable planetary caves. For simple economic and technical reasons, emphasis has shifted to building new worlds and new wealth in space from scratch.

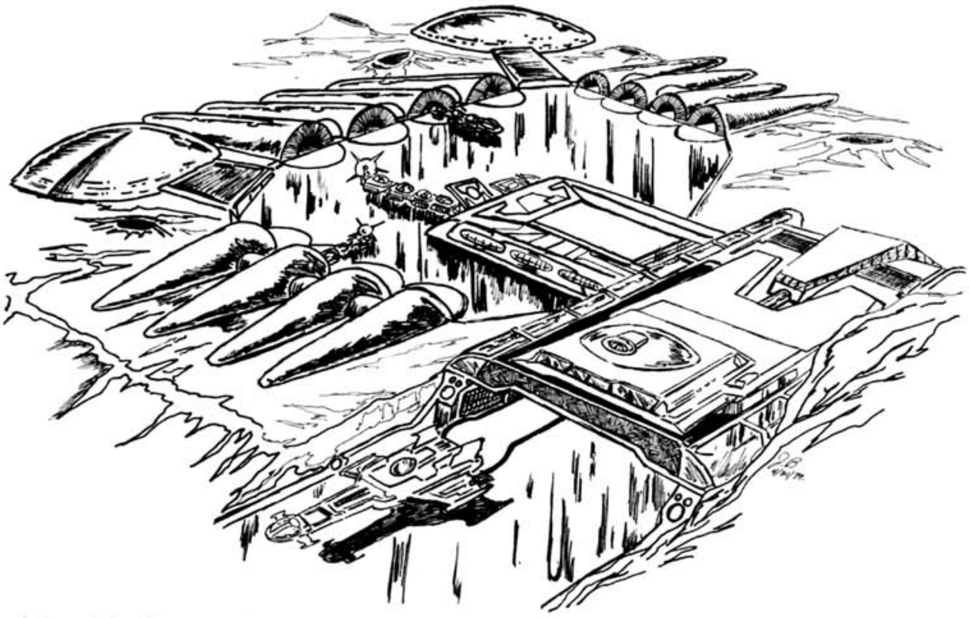
The idea of making places to live in space is far from new: science fiction and speculative projections have often featured domed cities, terraformed planets, and hollowed-out asteroids. But all these ideas propose modifying existing places to make large-scale habitations: a domed city—built on a planet; an Earthlike planet—made from a dead planet; a spinning, inside-out world—but hollowed from something, not built. Although many authors have written of building space stations from scratch (generally seen as small way-stations on the road to some **real** real estate) comparatively few before O'Neill had dared to think big.



Artwork by James Babcock

". . . a domed city — built on a planet; an Earthlike planet—made from a dead planet . . ."

The alternative to the old space program



Artwork by James Babcock

"Because of . . . airlessness and shallow gravity wells, the Moon . . . can easily supply materials for processing in free space."

is the New Space Program: economic development eventually leading to industrial colonies in free space, which would process lunar or asteroidal resources and support themselves by trade with Earth. In the public mind, this idea is replacing the expensive stunt with the sound investment, the dead Moon with the lush colony, and the test pilot's frontier with an endless new world to homestead. And suddenly, people are getting interested in space again.

The choice of where to go and what to do in space remains uncertain, but the outlines and opportunities are emerging. Although resources will determine where to go, the choice of which resources will depend on both their quality and accessibility. Since the terrestrial investors will expect a return, accessibility will depend on the cost of transportation from the mining site to near-Earth space.

On this assumption, the most accessible resources are those of the Moon and the Apollo-Amor asteroids. An electromagnetic catapult, called a mass driver, can make transportation from the Moon very cheap. Transportation from the Apollo-Amor asteroids (which lie well inside the main belt, crossing the orbits of Earth or Mars) can be made cheap by several means, including mass drivers used as reaction engines, and thin metal film solar sails.

By comparison, the planets seem unattractive. On most, the atmosphere prevents use of a mass driver to throw material into space, forcing reliance on some form of rocketry. Further, once off the surface, transportation of the materials to Earth costs more than it would from the Moon or a well-chosen asteroid. Finally, the planetary surface most accessible to mining, that of Mars, shows few signs of the age-old processing and re-processing of the crust that produced most terrestrial ore deposits.

For similar geological reasons, the Moon suffers from crustal blandness. In addition, the Moon has been baked to a virtually water-, nitrogen-, and carbon-free condition. Still, owing to its convenience (and, in particular, to the short travel time from Earth), the Moon may prove quite valuable. Like all rocky material, its crust contains oxygen bound in oxides of silicon and metals. These include iron, aluminum, magnesium, and titanium; together with silicon and oxygen these elements can provide most of the mass of a power satellite, an industrial plant, or a space colony.

Although the main shortcoming of [redacted] lunar materials is their lack of the biologically and industrially important elements hydrogen and carbon, the Moon is not yet completely explored. The permanently shadowed crater floors in the Moon's polar regions are intensely cold; some think they may have frozen and trapped gases escaping the lunar crust, together with water formed from solar wind hydrogen, and vapors blown from impacting comets. Instruments on a proposed lunar orbiter could detect these polar ices, but funds for the mission have been withheld: we finished with the Moon, remember?

The asteroids offer a tastier mix of resources; an industrial civilization could support itself quite comfortably on the materials in the belt. Some asteroids contain rocky material like the Moon's, others are blocks of alloy steel, and yet ohters are primitive materials left over from the solar system's formation, rich in carbon and water. Still others are mixtures of rock and steel. Asteroidal steel contains nickel and cobalt, with significant traces of copper, gold, and the platinum-group elements. Owing to its nickel content, its strength, toughness, and corrosion resistence exceeds that of most steels used on Earth today.

The water-rich, carbonaceous asteroids have never suffered melting or metamorphosis as have the rocky and metallic bodies. They contain virtually unmodified mineral grains and organic material from the earliest days of the solar system; while their overall compositions are strikingly uniform, their grain's compositions are strikingly diverse. Only research by mining and refining engineers can tell for certain, but this diversity could prove valuable. A typical bulk composition might include 10% water and 5% of an organic substance like that in oil shale.

How do we know so much about objects we've never visited? Well, things fall from the sky, people pick them up, and scientists analyze them. Other scientists observe how they reflect light and observe how asteroids reflect light. After correcting for terrestrial weathering effects, the differences between the surface of a meteorite broken open on Earth and an asteroid's surface in space, the difficulties of studying faint specks in the sky, and, of course, instrument problems, they compare spectra. And they find that meteorites match asteroids. This is fortunate, because no missions to the asteroids are now planned: Planets are more interesting, remember?

Because of their airlessness and shallow gravity wells, the Moon and asteroids can easily supply materials for processing in free space. But why process materials in free space, and not on the Moon, or an asteroid, or even a planet?

The ease of getting the materials into space and the low cost of energy there supply one motive. The energy needed to lift a kilogram of ore from the Moon is about 0.8 kilowatt-hours (from an asteroid, the energy needed is negligible). The energy needed to refine a kilogram of lunar ore, the added energy cost of hauling the dross into space will be comparatively small. And, with the need for cosmic ray shielding, even slag will have uses.

Since transportation takes little energy compared to refining (and assuming, as is often reasonable, that "energy costs" have some loose connection with true economic costs), it makes sense to take raw materials to where energy is cheap. Since fossil fuels won't burn in space, energy will come from nuclear or solar sources, depending on location and needs. In the inner solar system, for fixed, non-military installations like industrial plants, solar power appears to win hands down. While nuclear reactors are a fairly inexpensive source of heat, they do consume fuel and require considerable mass for their construction. In free space, a kilogram of inexpensive concentrating mirror can supply five to ten kilowatts of heat with no fuel costs whatsovever. The probable superiority of solar cells to any kind of heat engine merely widens the gap—where electric power is required.

On a planet, a solar electric power system suffers from grave handicaps. Winds and gravity multiply the cost of its structure, while dust and moving parts add to its maintenance costs. Expensive mechanisms must track the Sun during the day, and night renders the entire system useless half the time. If people or industry are to remain active at night, expensive energy storage systems must be built. For these reasons, nuclear power may win the cost battle for surface installations, unless-displaced by solar power beamed from space.

Even leaving energy aside, the advantages of free space for industry are substantial and unique, while the disadvantages are mild and easily overcome. The planetary environment offers industry two things: a fixed gravitational acceleration and some mixture of atmospheric gasses. Even if a process would benefit from these conditions, a cheap spinning structure like a space station can simulate an **optimal** gravity, and provide an **optimal** atmosphere. Although a planet's atmosphere can help carry away waste heat, mass-produced radiators can do the same in space (at a rate of several hundred watts per square meter at ordinary temperatures, and several thousand at elevated temperatures). Clearly, any process feasible on a planet is feasible in space.

In contrast, the unique vacuum and zero-gravity of space make many new processes feasible or more attractive. Zero gravity makes possible delicate separation processes, growth of very homogeneous semiconductors, and uniform solidification of very inhomogeneous composites (like foam steel). Some think that a number of such processes could yield products valuable enough to justify the cost of a round-trip into space on the shuttle, making them candidates for early space industries.

The absence of wind, weather, and gravity eliminates corrosion and most structures and to point them at the Sun. There, with careful shading, objects cool to cryogenic temperatures. With fixed concentrating mirrors of plastic film, heat in solar furnaces at 2,500°C becomes cheap.

Without gravity, weak forces exerted by induction coils or jets of gas can position molten globs in a furnace without physical contact, entirely sidestepping the bothersome and sometimes insoluble problem of container corrosion. With these methods adapted to no-contact plumbing, molten rock and steel can be handled by inexpensive, low-maintenance equipment in a continuous process. With no container corrosion worries, cheap, solar-powered, graphite-lined furnaces (patent pending) can make distillation of asteroidal steel practical. This will not only purify the steel, but recover copper, gold, and platinum-group metals, together with such unusual by-products as germanium and gallium. By venting steel or aluminum vapor out a nozzle and through the vacuum of space onto a form, condensed metal can be built up into plates or seamless hulls, perhaps for space colonies.

At this point the question "why build colonies in space, not on planets?" virtually answers itself: Trade, not government whim, will support colonies, and since the industries supporting trade will be in free space, colonies will be in free space.

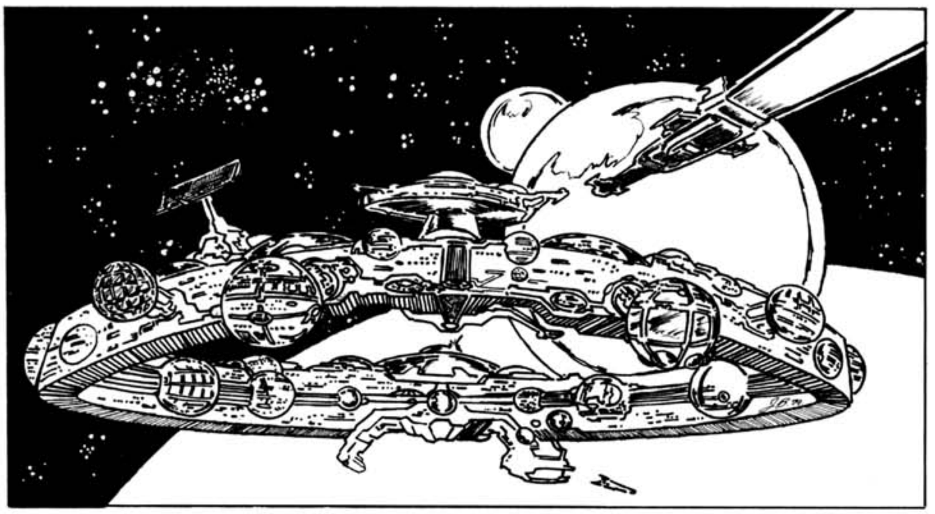
In all fairness to planetary bodies, they will draw some activity. Pre-processing of lunar rock and dust to concentrate useful materials may cut launch costs enough to be economic, and launching itself is a substantial activity requiring a Moon base. Some planets may have concentrations of rare minerals worth mining, many will draw scientific activities, and a few may eventually draw settlements and tourism.

Still, few people are apt to want to live on planets. All planets ever offered colonists, besides dubious raw materials and famous locations, was an unchosen gravity, an unchosen day length, an unbreathable atmosphere, and some stark scenery. Terraforming could perhaps produce a breathable atmosphere and improve the scenery—but for our distant decendents.

In space, colonists can choose their gravity, choose their day length, choose their atmosphere and their climate, and build...well, anything that will fit in a volume of a few hundred cubic kilometers or so. Solid city, airy tension structures, land, lakes, sunlight, and life—see any painting of an O'Neill colony for scope, then dream.....

And so the old patterns of thought have fallen. We will not "find wealth" in space, we will make it from barren rock and sunlight. The moving lights in the sky have less value than the invisibly faint asteroids, long though worthless. Land has little value in space because the best building sites are trajectories through vacuum. Exploitation and rule have no place, because space still lacks victims. Only the underlying notions of the Industrial Revolution—that wealth springs from ideas, investment, production, and trade—remain fresh. Only they can carry us into space, not to visit, but to live.

". . . the industries supporting space will be in free space. . ."



Artwork by James Babcock

Breakthrough!

According to recent studies, a combination of asteroid mining and high performance solar sails give us an early toehold on nonterrestrial resources. The price tag? It may be as low as $100 million.

by Carolyn Henson

Are you tired of hearing that solar power satellites are the only project big enough to justify space colonization?

Do you worry about putting all our eggs in the power satellite basket?

What we need is a really cheap route to nonterrestrial resources. So cheap we can easily justify setting up the heavily shielded (against cosmic radiation) habitats people need to permanently live in space. So cheap that we can build space farms and stop having to import our ham sandwiches from Earth. And we want those cheap resources soon.

Until recently the fastest, least expensive scenario was the "Low Profile Road" proposed by Gerard K. O'Neill (**Aeronautics & Astronautics,** March 1978, pp. 24–32). The keystones of this proposal are the use of lunar resources and the "mass driver," a linear electric motor that can either be used to fling rocks off the Moon or as a reaction engine in space with its rock-throwing action providing thrust.

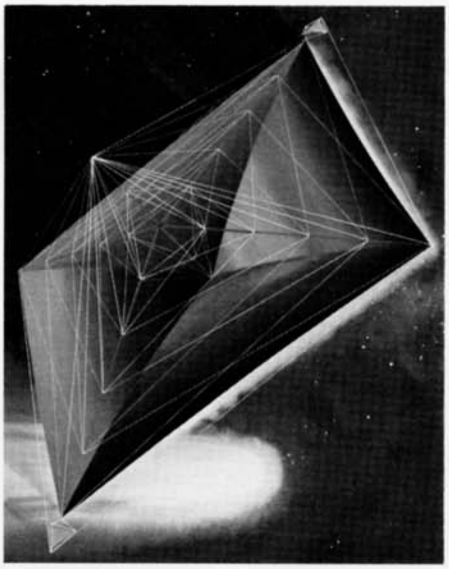
The space shuttle, for only a slight penalty in reduced payload, can leave its main fuel tank in orbit instead of letting it fall to burn up in Earth's atmosphere. O'Neill proposes grinding up these tanks for use as mass driver reaction mass.

The mass driver would carry 1,000 tons of equipment plus another 1,000 tons of fuel for a chemically propelled lunar soft lander. This equipment would be installed on the lunar surface. When completed the lunar base will include housing for 30 people, a Moon mine and a mass driver to throw rocks to L-2. A mass catcher would gather rocks there for transport via mass driver to an orbiting factory.

When these systems are all operating we will finally have a reliable supply line for nonterrestrial resources. The cost of this "low profile" scenario? One hundred shuttle flights. The development of mass drivers, lunar landers, a high orbit passenger vehicle, a mass catcher, lunar base and mine, and a space station. The estimated price tag is just under $10 billion. This part of the project would take 11 years.

That isn't unreasonable compared to the shuttle program, which will probably top $6.5 billion in research and development alone. But what do we get for this ten billion? Plenty of radiation shielding. Unprocessed rock two meters deep does just fine for stopping even the most energetic cosmic rays. We also get all the mass driver reaction mass we can use.

Unfortunately, it's a long way from lunar rock to some money-making space end product. O'Neill estimates a price tag of another $9.5 billion just to break down lunar rock into its component metals, oxygen and silicon. The next step is a dilly. Fabricating raw materials into end products is expensive, as anyone who has compared the price tag per kilogram of pig iron v.s. Mercedes Benz is aware. O'Neill estimated an investment of about $6.5 billion of research and development would set up a plant that could turn metals and silicon into power satellite parts.



Plastic film material solar soil.

This is a reasonable investment as part of a solar power satellite project. Power satellites could generate tens of billions of dollars per year of income. But no other project or group of projects on the NASA drawing boards could justify this "low profile road."

Former O'Neill research assistant K. Eric Drexler has followed another line of research. Substitute solar sails for mass drivers and asteroids for the Moon and we may get nonterrestrial resources for an investment of well under a billion dollars.

The Case for Asteroids

Many asteroids are actually closer, in terms of "delta-V," than the Moon. In space, distances are nearly meaningless. Orbiting objects follow their Keplerian choreography, changing relative positions constantly. What's really important is the change in velocity, or delta V, an object must undergo to move from one orbit to another.

A round trip from the surface of the Earth to the Moon requires a 9 km/sec delta-V. A round trip to the asteroid 1943 Anteros needs only an 8 km/sec delta-V. A "shortcut" using a double gravitational slingshot maneuver around the Moon brings the delta-V down to 2.2 km/sec. Using the same maneuver 1977 HB Bacchus has a delta-V of 3 km/sec.

Asteroids are far richer sources of materials than the Moon. The Moon lacks hydrogen (necessary to make water), nitrogen and carbon, elements essential to life. Lunar oxygen, aluminum, titanium and silicon are tied up in hard to smelt compounds such as silicates. To put it bluntly, known lunar resources are about as poor ores as ordinary Earth rocks and dirt.

However, on the basis of meteorites that have struck the Earth, and asteroidal reflection spectra, we can tell that many asteroids contain rich ores. Nickel/iron asteroids such as the nearby 77 VA Amor contain huge lumps of nearly pure nickle/iron steel. And their impurities are worth looking at twice: chromium, cobalt and platinum. Carbonaceous chondritic asteroids, such as the nearby Ra-Shalom, contain water and carbon in large quantities, and significant amounts of the biologically critical nitrogen. The water can be extracted by simple distillation.

Why Solar Sails?

According to Eric Drexler,

> "Sporadic studies of solar sailing stretch back well over twenty years. For obvious reasons, nearly all serious studies have focused on launchable, deployable sails, made of necessity from comparatively rugged plastic film materials. The recent renewal of interest in solar sailing

> sprang from a Jet Propulsion Laboratory design study, which showed the feasibility of deployable sails of impressive performance.[1]
>
> Space-manufactured thin-film materials promise sails with 20 to 80 times the performance of the best deployable sails; this would seem to justify a re-examination of solar sailing."

What are the environmental implications of solar sails?

> "Most of the light reflected from high performance solar sail (HPSS) spreads in a cone some tens of degrees across, and need never be directed at Earth's night side. Still, some light will be scattered in all directions, and sails maneuvering at a few Earth radii will be visible over much of Earth's night side for part of every orbit. Scattered light might become bright enough to affect astronomical programs involving faint objects. If so, the problem may be alleviated, even for heavy sail traffic, by arranging sail schedules so as to leave the skies completely free of sails most of the time (convoying). Eventually, instruments in space will more than make up for lost observing time on the ground.
>
> 'At some altitudes, orbital debris would pose a substantial hazard for sails, if they were left uncontrolled. All significant orbiting objects are tracked, however, and hence may be avoided. Further, HPSS technology can be scaled down to produce small, cheap vehicles with unlimited delta-V capability. Such vehicles, with suitable payloads, would make fine orbital garbage trucks, collecting debris economically."

Solar Sail Uses

While solar sails appear to be ideal for asteroid mining missions, they have many other potential uses. Their possibly as low as $100 billion research and development price tag could be justified by any one of the following:

> *Such sails can serve as reusable interplanetary shuttles for delivery of orbiters, landers, penetration probes, etc., and can return samples from low planetary orbits to low Earth orbits.
>
> *Their unlimited delta-V capability allows asteroid survey missions of indefinite length.
>
> *Their high performance permits a rendezvous mission to Halley's comet with a flight time well under a year, and permits **pre-perhelion** rendezvous missions, with subsequent sample return, to objects on parabolic trajectories.
>
> *Their high performance permits not only fast out-of-the-ecliptic missions, but establishment of permanent solar polar observatories (see Figs. 6 (a) and (b)).

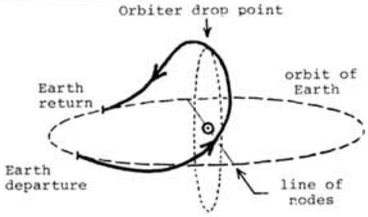


Figure 6 (a). An out-of-the ecliptic mission trajectory with sail return.

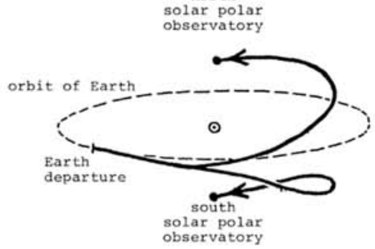


Figure 6 (b). Solar observatory mission, trajectories and operating stations. Payload about 150 kilograms per newton of sail thrust.

> *With the aid of rocket stages, they can deliver large payloads into orbits around the outer planets with short mission times.
>
> *They can perform 1.5 year flyby missions to Neptune and Pluto.
>
> *Since they can deliver substantial payloads to solar-escape trajectories with hyperbolic excess velocities of 100 to 200 km/sec, they can greatly speed the exploration of the heliosphere and the nearby interstellar medium. Delivery of x-ray telescopes to such trajectories would permit measurement of the distances to certain suspected black holes, after a few years flight time, based on their rapidly flickering intensities and the curvature of the oncoming x-ray pulse. In a decade or so, astrometric equipment on such trajectories could measure parallax and hence distance for any visible object in our galaxy.

However, the "big time" is retrieval of nonterrestrial resources. According to Drexler,

> "Historically, a great barrier to the use of non-terrestrial resources has appeared to be the high initial cost of the recovery systems. Nothing short of the solar power satellite program has appeared to justify the expense of the development, construction, and emplacement of a lunar base, mass driver, mass catcher, and other system elements necessary for the lunar scenario. The HPSS, on the other hand, provides a reliable, low-cost, deep-space transportation capability well suited to operation without crew maintenance. With it available, the threshold to nonterrestrial resource recovery may apparently be crossed with a single shuttle payload.
>
> Figure 7 illustrates one approach to the surface mining of a small asteroid, based on a device which sweeps up loose surface matter and places it in a bag. Such a device may have many redundant sweeping heads, and seems unlikely to require human attention. A 200 ton sailload, appropriate to a 100 newton force sail, may be swept up in under a month at a rate of one tenth kilogram per second. A few millimeters thickness of loose surface material would suffice for many loads of this size, which may be returned with trip times on the order of a year. Two accessible asteroidal bodies with much loose material are already known: the moons of Mars. It would be ironic if they proved more attractive than our own."

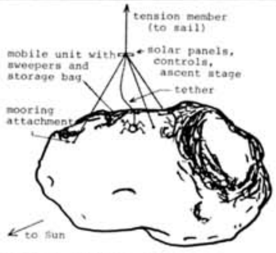

tension member (to sail)
mobile unit with sweepers and storage bag
solar panels, controls, ascent stage
tether
mooring attachment
to Sun

Figure 7. Asteroid mining concept. The sail is moored over the "winter" hemisphere of the asteroid by means of penetrators.

The U.S. Department of Defense might develop an interest in extraterrestrial resources.

> "Asteroid resource recovery systems open a range of non-solar power satellite scenarios for space development. Demand for a few hundred tons of asteroidal material for radiation shielding could justify mining operations. Military demand for asteroidal steel to harden orbital installations could easily exceed 10,000 tons (or 100,000 tons, for that matter). Mass transport rates of this order of magnitude would drop the total amortized program cost per

> kilogram returned into the $2-20 range. Incremental costs for sail production would be low, and incremental costs for the use of existing sails would be almost negligible."

In the longer run, asteroid mines may sell their products to Earth surface customers. Drexler points out that:

> "Many asteroids apparently contain a good grade of steel, with a typical cobalt content around 1% and a nickel content around 10%. Sail transportation costs from Apollo objects, at substantial traffic levels, should fall below $50/kilogram. This may be compared with the market prices and world demands for cobalt (about $10/kg and 20,000 tons/year) and nickel (about $5/kg and 700,000 tons/year). If a suitably low-cost concentration or purification process can be found, and if return of materials through the atmosphere proves as inexpensive as expected,[2] these metals might be sold on Earth. World markets are several billion dollars.
>
> A large market might also be developed for foam steel. It should be easy to produce in space, and would require little refining of the raw material. Its unique properties might bring a price of several dollars per kilogram (roughly comparable to that of some wood products).
>
> Preliminary estimates of the cost of mass-produced solar sails, using nonterrestrial feedstocks and a shuttle-derived heavy lift launch vehicle for equipment transport, fall around 0.75¢/m^2, yielding transportation costs around 6¢/kg from a suitable asteroid. Since pig iron sells for over 20¢/kg, and steel bars, plates, etc. for over 40¢/kg, a nonterrestrial steel production industry is not out of the question. U.S. demand for pig iron is presently over 70 million tons per year; worldwide demand is almost 500 million tons per year. Cheap process heat, zero gravity, and accessible vacuum all make space attractive for steel processing. Steel and cheap energy as a basis for industrial development is an old story."

References

1. Friedman, L., et. al., "Solar Sailing — The Concept Made Realistic," 16th Aerospace Sciences Meeting, January, 1978, AIAA Paper No. 78-82.

2. Gaffey, M. J., and T. B. McCord, "Mining Outer Space," **Technology Review, 79** (7):50, June 1977.

High Performance Solar Sail Concept

by K. Eric Drexler

High performance solar sails (HPSS) are truss structures built from tension members which support reflective panels assembled from vapor-deposited films 15 to 100 nanometers thick (see Fig. 1). Light pressure and payload inertial reaction provide axial tension, while slow rotation provides radial tension. HPSSs are expected to have high performance, low cost, and high reliability because of their low mass, ease of fabrication, and virtually passive mode of operation.

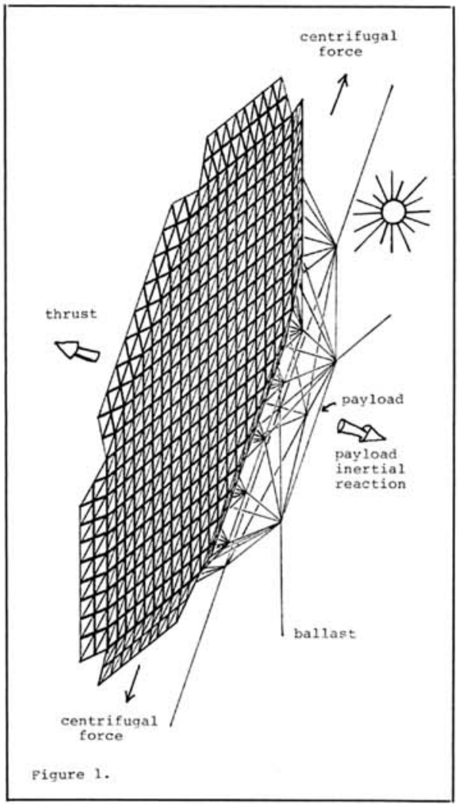


Figure 1.

The core of the HPSS production system is a device which fabricates and mounts sheets of thin-film material. Film sheets are fabricated by depositing a sublimable material and then the reflective film onto a moving belt of metal foil, and then incising the film to separate it into sheets. The sheets are then mounted by gluing springy foil tabs to their corners, and freed by subliming away the intermediate layer through perforations in the foil or the film. This approach can apparently produce thin film sheets in a continuous stream while subjecting them to negligible loads. Two alternative approaches with different risks but similar results are proposed. Preliminary estimates suggest that a 3,000 kg device (inclusive of power supply) can produce some 3x10^7 m^2 of film sheets per year. Another device assembles the sheets into triangular panels framed by tension members, which are accumulated for subsequent assembly to the sail structure. Together these devices make up a panel fabrication module, with a mass around 4,000 kg.

The sail's main tension structure is launched as a compact package, and then deployed from reels. Deployment takes place within the confines of a centrifugally-tensioned scaffolding structure incorporating six parallel beams. The main plane of the deployed sail structure is a hexagonal triangulated grid. A crane attached to the scaffolding conveys panels from the fabrication device to apertures in the grid, where they are hooked onto the structure. All fabrication and assembly operations may be accomplished without direct human intervention.

Air drag imposes an operational floor on solar sails between 700 to 900 km altitude. If sails are made below this altitude, they must be kept in orbit during manufacture by constant thrusting. Thrust requirements have not been estimated, but may be minimized by proper choice of sail attitude. If sails are made above this altitude (prior to the establishment of a high-orbit station), all equipment must be designed for maintenance or replacement by teleoperator, owing to the radiation environment of intermediate altitude orbits.

After panel installation and release from the scaffolding, the sail becomes operational. The sail's attitude to the Sun then determines the direction and magnitude of its thrust. Since the sail spins, changes of attitude require a precessing torque. Tilting some of the panels produces torque for spin-rate control of slow precession; shifting the payload to an off-axis position in inertial space will produce torque for faster precession. In near-Earth maneuvers, the latter method would be used, permitting the sail to precess at rates around five radians per hour. In interplanetary flight the first method can be used, and the sails may be left passive for weeks at a time.

Development and Implementation Considerations

The only system elements embodying substantially new technology are the film fabrication device and the film sheets themselves. The fabrication device has moving parts comparable in complexity to those of the beam-builders already under development for space use. Adequate control of the various substances handled will require careful design (baffles to confine vapors, bearings sealed against loose flakes of vapor-deposited materials, etc.). The device is designed to deposit and free the film sheets under conditions better than those commonly employed in the laboratory for producing unbacked films even thinner than those proposed for use in the HPSS. Several candidate film materials are fairly well characterized, and have strengths over 1,000 times what the present application demands.

The greatest uncertainties in the system—the minimum practical film thickness and the optimal film composition—have little effect on the system design. They affect the 'sail's acceleration and maneuverability, but the proper choice of sail rotation rate negates effects on the sail's structural design or major internal modes of vibration. They affect the design of the evaporators in the film fabrication device (and the sizing of their power supply and cooling system), but the design of the rest of the sail manufacturing system remains unaltered. Figure 2 indicates the range of uncertainty in the sail's final mass and performance. Since the worst likely case yields excellent performance, and since these uncertainties are effectively decoupled from program risk, they may be greatly reduced by a very modest experimental program of film deposition and testing.

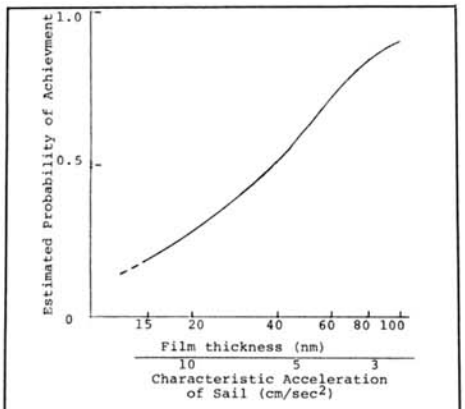


Figure 2. Estimated probability of achieving films of various thicknesses and sails of various performance levels.

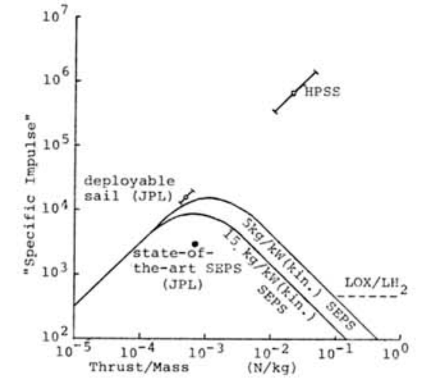


Figure 3. "Specific impulse" (see text) vs. thrust to mass ratio for various systems. Current SEPS from reference 6.

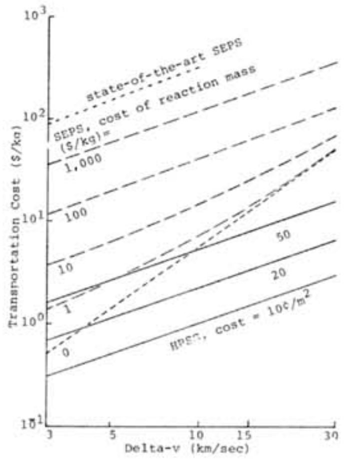


Figure 4. Comparisons of HPSS and SEPS costs. See Table 1 for assumptions.

The balance of the system presents the typical problems of the design of a reliable, maintainable mechanical system. A preliminary estimate of the masses of the system elements to be developed is five tons. Applying a typical aerospace development cost of $20,000/kg to this mass yields a crude development cost estimate of $100 million. A substantially higher development cost could clearly be tolerated, if the system proves attractive enough.

The total mass of a system able to produce sails of 1 to 100 newtons thrust (0.5 to 5 km diameter) is estimated to be around 13 tons (a smaller scaffolding with lower mass is apt to be built during development). Such a system could produce sails with thrusts totaling 200 N in a year's time, and this capacity could be expanded in 200 N/yr increments by the addition of four-ton panel fabrication modules. Sails of greater thrust could be made by clustering smaller sails or by means of the construction of a larger scaffolding. The basic system, together with raw materials for sails totaling several hundred newtons thrust can apparently fit within the mass and volume constraints of a single shuttle launch.

Performance Comparisons

To be of practical interest, the HPSS must outperform its competition in a sufficient range of applications. At present, the competition is the solar electric propulsion system (SEPS), using either ion engines or possibly mass drivers for conversion of electric to kinetic energy. The latter system is an efficient, omnivorous mass accelerator proposed for industrial-scale space propulsion.

Two performance parameters commonly compared among thrusters are specific impulse and thrust to mass ratio. Strictly speaking, the specific impulse of any sail is infinite, as it expends no mass. Still, sheet metal makes poor sails. In the spirit of amortization applied to durable goods, a performance measure related to specific impluse may be calculated by introducing a fictitious expenditure of 10% of the vehicle's mass per year, and adding this to any mass actually expended. Sail thrust characteristics are also unusual: as a sail varies its angle to the Sun, its thrust varies in both magnitude and direction. For heliocentric trajectories, the useful component of thrust is frequently that perpendicular to the radius vector from the Sun. On this basis, the useful thrust of a sail is about 38% of its maximum thrust.

Figure 3 plots the measure of "specific impulse" described above as a function of the (useful) thrust-to-mass ration for sails of varying mass per unit area, at Earth's distance from the Sun, and SEPS with varying specific powers and exhaust velocities. As may be seen, the HPSS greatly outperforms state-of-the-art, multi-mission ion-engine SEPS, in both dimensions. An idealized (or mass driver) SEPS can exceed the sail's thrust-to-mass ratio, but only at a low specific impulse, or with a very high specific power.

Preliminary Cost Comparisons

For industrial applications, the unit cost of transportation is of central concern. SEPS costs will depend on the delta-V of the mission, and on the costs of the reaction mass and the kinetic energy in the exhaust (the latter amounts to the cost of vehicle amortization). HPSS costs will depend on the cost of the sail, its distance from the Sun, and the efficiency with which its thrust may be used. The following comparison will neglect other costs for both systems, and hence cannot be considered to represent total costs.

Figure 4 presents such a cost comparison. Table I summarizes the assumptions used, intended to represent an early era of space development. As may be seen, sail costs are lower than state-of-the-art SEPS costs across the board. The advanced, idealized, mission-optimized SEPS beats the more expensive sails at low enough delta-V, if a cheap enough source of reaction mass can be found. However, even the cost of mass-driver derived lunar materials has been estimated at over $1/kg.

Figure 5 graphs comparative costs in the context of a solar power satellite program. Table 2 lists the assumptions used. Once again, SEPS appears competitive only with low reaction mass costs, and at low delta-V's.

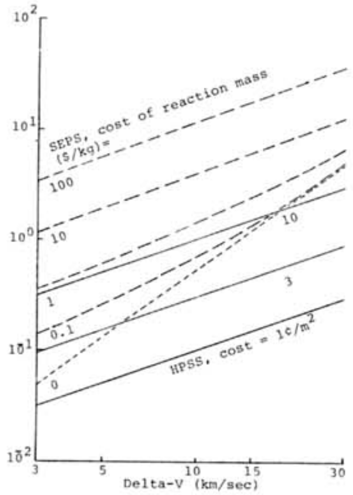


Figure 5. Comparison of HPSS and SEPS costs in the context of an SPS program. See Table 2 for assumptions.

Conclusions and Recommendations

In light of the unique capabilities, extreme versatility, low transportation costs, and modest development cost promised by HPSS, this concept seems worthy of review by aerospace groups. If this promise holds up under closer scrutiny, work should begin to improve sail and sail fabrication facility design, to improve understanding of the proper role of the HPSS in space activities, and to initiate development of the sail fabrication technology itself.

Acknowledgements: The author would like to thank the National Science Foundation for its support during the greater part of this work, and the members of the JPL solar sail design teams: without them, this work would never have been done.

More details are available in "High Performance Solar Sails and Related Reflecting Devices," Eric Drexler, AIAA paper #79-1418, May 1979. This paper was presented at the 1979 Princeton Space Manufacturing Conference.

Table 1. Cost assumption for Figure 4.

General Assumptions:

Discount rate, 10%

Cost of equipment purchase, $600/kg.

Cost to transport to orbit, $700/kg.

Only the cost of equipment, materials, and their transport to orbit is considered.

HPSS:

Cost of structure purchase, $600/kg.

Cost of evaporator feedstock purchase neglected.

One panel fabrication module used at capacity in a large scaffolding.

The resulting cost is 12 to 26¢/m², depending on film thickness.

SEPS:

"State-of-the-art SEPS" curve represents a JPL multi-mission design, costed as above.

Other SEPS are assumed to have mission-optimized exhaust velocities, and to be able to supply kinetic energy to the exhaust for 25¢/kw-hr. This corresponds to a 70% efficient system with a mass of about 12 kg/kw (electric), costed as above.

Curves are plotted for various assumed reaction mass costs.

Table 2. Cost assumptions for Figure 5.

General Assumption

Cost of transport to orbit, $100/kg.

Other assumptions as in Table 1.

HPSS:

Cost of structure purchase, $200/kg.

Cost of evaporator feedstock neglected.

Many panel fabrication modules per scaffolding.

$600/kg for initial module purchase, 80% learning curve applies to the cost of enough modules to provide 100,000 tons/yr transport capacity to geosyncronous orbit after 5 years production.

The resulting cost is 1.5 to 3.5¢/m², depending on film thickness.

SEPS:

Same assumptions as in Table 1, but 2.5¢/kw-hr (a commonly quoted target cost for SPS electrical energy delivered to the ground) is assumed as the cost of kinetic energy in the exhaust.

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Annual Rocky Mountain Guidance and Control Conference, 1978, March 10-13, 1978, Keystone, Colorado. Approximately 16 papers available in hard copy. Price: $20. Individual papers $2 each. (22 papers are available on 6x4 microfiche, Volume 29, AAS Microfiche Series. Price: $18.)

The Industrialization of Space—just published on microfiche—Volume 28, AAS Microfiche Series, 1978, 20 papers, 9 microfiche, $15. (Suppliments Volume 36, Advances in the Astronautical Sciences.)

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Salyut-6
Step Towards a Permanent Space Station

by James E. Oberg

The latest Soviet piloted space launch involving a Bulgarian cosmonaut briefly attracted public attention to the Salyut-6 space station mission. Soyuz-33, launched April 10, was also the first Soviet piloted spaceship commanded by a non-pilot civilian engineer.

But the space breakthrough of 1979 had already been in progress, unheralded by the news media. For seven weeks, unnoticed by most of the world, the crew of Soyuz-32 had been working on board the Salyut-6 space station. What they have accomplished marks a major advance in space exploration, perhaps the most important single space feat since the first inhabited space stations were launched in the early 1970's.

Cosmonauts Lyakhov and Ryumin (temporarily joined by cosmonauts Rukavishnikov and Ivanov) have opened the way to the establishment of orbiting space stations of unlimited lifetime. By their repair and refurbishment of the eighteen-month old Salyut space lab, they have given proof of the USSR's serious intentions to carry out what has up until now been only a promise: "We believe that permanent inhabited orbiting space stations with interchangeable crews will be the main road into space," goes the litany repeated time and time again by Soviet politicians, cosmonauts, and space scientists. That forecast has moved measurably closer to reality with the flight of Soyuz-32.

For seven weeks, unnoticed by most of the world, the crew of the Soyuz-32 has been working on board the Salyut-6 space station . . . (they) have opened the way to the establishment of orbiting space stations of unlimited lifetime.

"Salyut" is the name of the Soviet inhabited space station program, in some ways comparable to the U.S. Skylab project of 1973-1974. The Salyut design is smaller than Skylab, with lower electrical power capacity, a lower orbit, and less sophisticated instrumentation. It generally operates with a crew of two, compared to three on Skylab (and, unlike Skylab, the Salyut has never hosted true scientist-astronauts).

But the Salyut program, unlike the one-shot Skylab, is an ongoing program. New improved Salyuts are launched about once per year, are visited in sequence by different teams of cosmonauts, and then are safely crashed into the uninhabited North Pacific at the end of their missions.

The latest Salyut, numbered "6" but actually at least the eighth in the series which began in 1971, has incorporated an operational capability for double docking of ferry ships, for crew replacement "on the fly", for automatic resupply, and for advanced space walk systems. Using such technology, backed by a remarkably confident flight planning process, cosmonauts have smashed all American space records from the Skylab program.

The key difference on Salyut-6 is in the way it has been designed to facilitate repair. It is the first space station so conceived. All future space stations will be built this way.

On Skylab and on earlier Salyuts, the ability to repair equipment and restock consumable supplies was the main limiting factor on how long the space stations could remain functional. The efforts by Skylab astronauts to replace sun shields, unfold balky solar power panels, repressurize coolant lines, and perform similar tasks, were all newsworthy and exciting. Less well known was the fact that such tasks were made more difficult by the basic design of Skylab, which did not allow for easy in-flight maintenance and replacement.

After about a year or two at most, space equipment wears out. Even if breakdowns do not occur, the performance and reliability of the equipment are seriously degraded. On Skylab today, after five years of cold storage, the newly repowered systems have been failing one by one, eliminating the chance that the space station could have remained under control even if its orbit had not been decaying so rapidly.

The Soviets on Salyut-6 have overcome this basic inherent lifetime limitation by a two-fold approach. First, practically all of the internal systems of the Salyut are modular in design, and can be replaced piecemeal with new equipment sent up in robot freighters of the "Progress" type. Second, systems which cannot be so easily renovated (such as solar panels) can be augmented by supplementary equipment on newly attached modules launched separately.

The technology of this approach, while not particularly sophisticated, is impressive for its flexibility. "Progress" robot ships, for example, can deliver more than five thousand pounds of cargo and rocket propellants, and can transfer that payload onto the Salyut — the cargo via manual handling, and the liquid propellants via pressurized lines (in-flight ship-to-ship fuel pumping has never been accomplished by the U.S.). Special modules loaded with auxiliary power packs, rocket engines, or laboratory equipment promise to give the Soviets soon a capability similar to that planned for the U.S.—European Spacelab program of the early 1980's.

Frequent flights between the space station and the Earth allow Soviet space engineers to study results of cosmonaut experiments which have been returned, plan changes to the procedures, and send new instructions back up to the crew on subsequent flights. A major new advance in this procedure was implemented in March with the installation of a television screen and video recorder unit on the Salyut. New procedures, documents, blueprints, and other visual information can now be transmitted to the spacemen for study. This supplements a teletype unit which was already in service.

The current plans for the duration of the present space station crew are not known. Soviet space medicine experts have expressed guarded satisfaction with the re-adaptation of the cosmonauts who spent 140 days in space last summer and fall. Ground tests and some vague public statements suggest that the Soviets are aiming for an ultimate duty tour in space of about 365-380 days. Their past practice of extending each long flight by about 50% over the previous flight suggests that a mission duration of 230 days for the present crew is logical. They would thus come back to Earth next October, after having been relieved by a new pair of cosmonauts who would be aiming at twelve months in orbit.

However impressive the current Salyut-6 achievements may be, they represent only the tip of the iceberg of forthcoming Soviet piloted space activities.

Such long flights exceed the orbital operating lifetimes of Soyuz transport ships. That is why periodic launches must occur for visiting crews for exchanging spaceships, returning to Earth in the nearly worn out Soyuz and leaving their fresh spaceship attached to the Salyut. Their visits are also useful for logistics and psychological reasons.

Since such flights are routine and not particularly challenging, the Soviets have allowed representatives of their satellite countries to fly on them. Such "guest cosmonaut junkets" are essentially public relations gimmicks, since the foreign visitors are not sufficiently trained to make any significant contribution to the success of the main mission. Their propaganda value, however, is immense, and they do represent one reward for the political loyalty of their countries and for a genuine program of Soviet bloc cooperation in space science.

However impressive the current Salyut-6 achievements may be, they represent only the tip of the iceberg of forthcoming Soviet piloted space activities. Over the past several years, a mysterious series of unpiloted orbital test flights has proved out several different types of advanced pilot-related space hardware. These vehicles, which may include auxiliary Salyut docking and power modules, a space tug, and an small "lifting body" reusable piloted spacecraft which can land at an airport after its flight, have yet to become operational, but this is expected to occur over the next year or two.

During that time, the Soviets will probably make it clear that they have every intention of establishing a permanent presence in orbit, with tired space crews being replaced by fresh cosmonauts. The assembly of larger space stations out of modules launched separately is another theme often discussed in the Soviet literature, and it would make good sense to do such a thing. Several different specialized Salyut stations, some for scientific research and some for military reconnaissance, will probably be set up. Salyuts could also be sent into lunar orbit within five years.

All these present accomplishments, and the obscure but highly suggestive space tests of the last few years, indicate that a major change in space operations is now occuring. Cosmonauts have established a bridgehead into space and will be expanding it, utilizing space stations for scientific, industrial, medical, and military purposes.

Our Space Shuttle and Spacelab, once operational, may go a long way towards redressing this imbalance of operational capabilities.

But the Salyut is operating today, and the Soviets, too, have big plans for piloted space flight in the future.

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More Mystery Soviet Space Tests

Another mystery human-related Soviet spaceship has completed an orbital test flight, space watcher Jim Oberg reports from Houston. Kosmos-1074 was launched on January 31 and was recovered April 1 on a mission just one hour short of sixty days.

The vehicle appears to be part of a test series which began with Kosmos-869 (late 1976) and Kosmos-1001 (April 1978), possibly leading to use of a larger-capacity piloted spacecraft descended from the current two-seat Soyuz. Kosmos-1074 was apparently about the same size and weight of the present Soyuz design but may have been of a different configuration, based on visual observations from Texas.

Based on a past analog to this mission, the new vehicle (possibly with a crew of 4 or 5 cosmonauts) could become operational later this year. The 60-day Kosmos-613 flight in 1973-1974 was a precursor of the Soyuz spacecraft used on the Salyut-4 missions of 1974-1975; a similar 10-12 month delay may now ensue before Kosmos-1074 becomes operational, or, with greater confidence which now characterizes the Soviet space effort, that period may be cut in half.

Alternately, Kosmos-1074 may represent a special Soyuz-based "laboratory module" which, according to Soviet space officials, is being prepared to transport special already-assembled pieces of scientific and industrial equipment into orbit, as a complementary approach to the progress freighter-tankers. Samples could be returned to Earth in an unoccupied Soyuz.

Only time will tell, Oberg concedes, but he warns that the test series, and other even more mysterious tests, presage major new Soviet space advances in the next 12-18 months.

Evolving Shuttle Designs

by Leonard David

In a time of nationwide economic constraints, the message for space planners is clear — "make do with what you've got." With the Space Shuttle as this country's main space transportation system, engineers are investigating a multitude of concepts that will literally and figuratively stretch the Shuttle's abilities far beyond its initial design. Such improvements could have tremendous impact upon the building of large structures such as satellite power systems or, conceivably, space habitats.

Advanced studies by Rockwell, Boeing, Johnson and Marshall Space Flight Centers indicate the possibility of using "kits" to modify and adapt basic Shuttle system elements to extend the Shuttle Orbiter's life-time, increase payload delivery weight and volume to orbit, and even create the first space passenger plane!

Currently, the base-line Shuttle can carry up to 65,000 lbs. within its 60 x 15 foot cargo-bay. However, space engineers are devising modificatins to the Shuttle which would enable it to boost almost 5 times as much weight! An early possibility for Shuttle upgrading would be more modest, however, involving use of additional solid rocket motors positioned on the end of the Shuttle's external tank. This technique would permit delivery of payloads up to 93,000 lbs.

One design by Marshall Space Flight Center centers on fully reusable, liquid propellant, rocket powered boosters, instead of the conventional solid strap-on engines now planned. The reusable liquid propellant boosters would increase the Shuttle's payload-into-orbit capability to 100,000 lbs.

One plan, devised by Rockwell, has demonstrated the feasibility of turning Shuttle vehicle hardware into a Heavy Lift Launch Vehicle (HLLV). This design would utilize present Shuttle external tank and solid rocket boosters, and the Orbiter's aft fuselage, modified into a fully reusable propulsion module. This concept would produce an HLLV with at least a 170,000 lb. lift capability. It's rumored that Rockwell has one Shuttle derived modification that could loft up to 300,000 lbs. into space!

Since 1975, Rockwell engineers have studied options to extend the duration of the Shuttle orbiter beyond its current 30 days of maximum spaceflight. Changes in electrical power subsystems, based on a deployable solar cell array kit, coupled with the Shuttle's fuel cell subsystems, and improved techniques for storing or recycling water, would give the Shuttle up to 180 days of life. The technology to develop these extended duration subsystems exists today, states Rockwell designers.

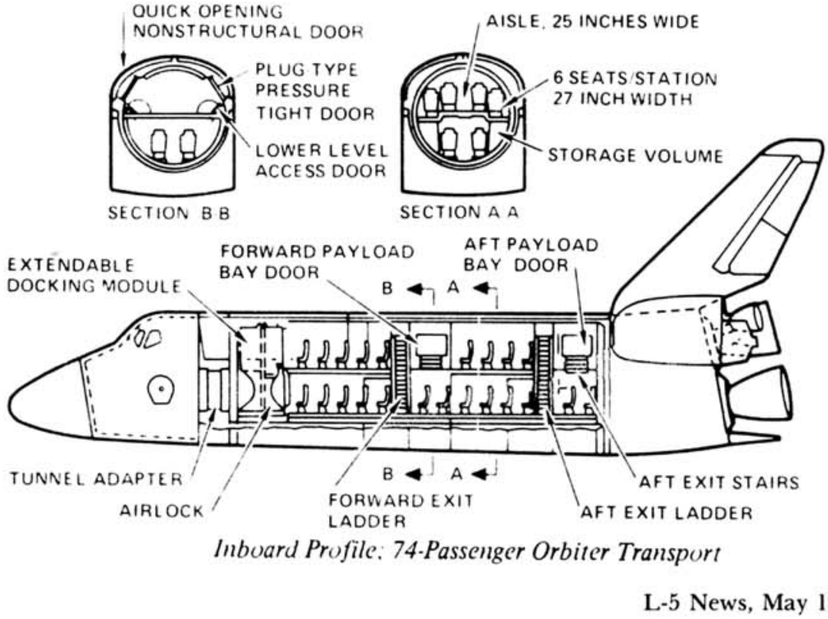
. . . engineers are investigating a multitude of concepts that will . . . stretch the Shuttle's abilities far beyond its initial design. Such improvements could have tremendous impact upon the building of large structures such as satellite power systems or . . . space habitats.

Additional studies have also been underway which allow for larger diameter and longer payloads. Currently, payloads of only 15 feet in diameter can fit inside the Shuttle's cargo hold, but conceptual studies indicate the need to handle wider payloads. Shuttle designers believe the Shuttle's external tank can be modified to house extra payloads, up to 37 feet in diameter and weighing 47,000 lbs. Once the Shuttle's main engines have cut off, a special shroud on the external tank would open, with the payload separating from the tank under its own propulsion system.

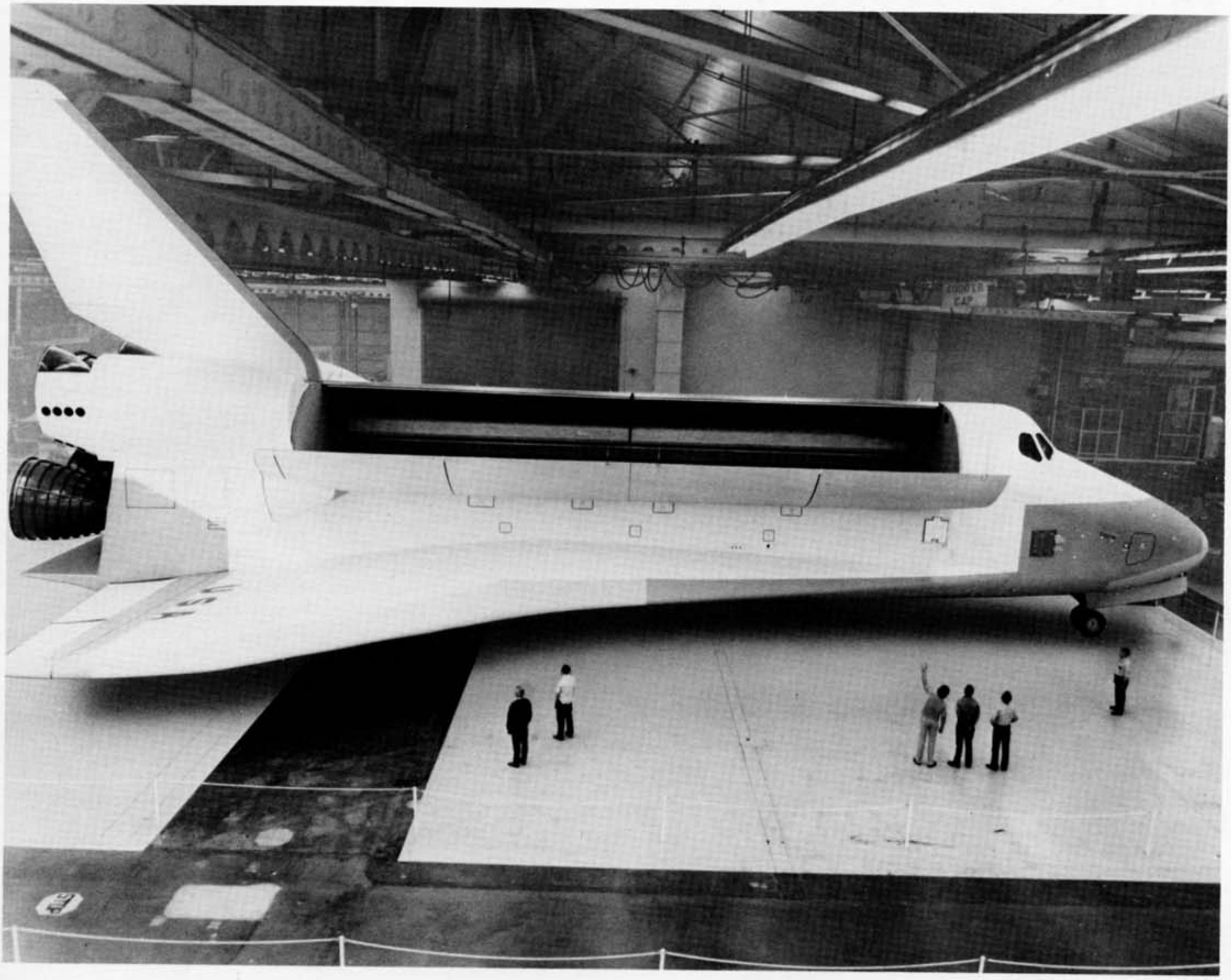
One option also available is to physically "stretch" the Shuttle orbiter by adding an extra section to its fuselage — a process similar to that already in use by commercial airline companies. This extra-long orbiter (longer by 16.5 feet) would require some modification of the wing sections and landing gear, allowing payloads up to 100,000 lbs. and 76 feet long. The modifications would result in a Shuttle with almost identical stability as its current design.

For those missions which will require delivery of payloads to geosynchronous orbits and beyond, both NASA and Rockwell studies envision the possibility of using one Shuttle to carry into space a core vehicle, capable of being piloted. Once the core stage is orbited, subsequent Shuttle flights would surround the stage with fuel tanks. Depending on the mission, up to six of these fuel tanks could be strapped to the core vehicle. It is possible future piloted flights to the Moon or planets may utilize this technique. The concept could be supported by the current Shuttle transportation system.

The most intriguing extension of the



Inboard Profile: 74-Passenger Orbiter Transport



Shuttle designers investigate new uses for the space transportation system — including a passenger-carrying system.

Shuttle is an L-5er's dream come true — a passenger-carrying orbiter. Rockwell engineers have studied a passenger transport kit which can hold up to 74 passengers for trips to and from low orbit. The passenger kit would be designed with special exit ladders and stairs for normal entry and unloading, and in case of emergencies. The kit, which would cost upward of $220 million, would include added life support equipment, seating and supplemental environmental control systems. Some modifications to the orbiter's wing would be needed, to accomodate the passenger module. It is conceivable with such future plans as building large structures in space, the need for construction crews may make this Shuttle design a practical possibility. No word yet on first class or coach seating arrangements!

As one Rockwell advanced study concludes. "The Space Shuttle System design has been shown to be economically adaptable to a wide spectrum of advanced missions, substantially more demanding in their requirements than envisioned when the Shuttle system requirements were delineated. This economical growth potential, coupled with the fundamentally new capabilities being introduced by the Shuttle for payload recovery and reuse, on-orbit construction, assembly, maintenance and repair and performance of other complex functions, is expected to result in an extended program lifetime. We can anticipate rapid evolutionary growth of operational space mission capabilities during this program lifetime."

The most intriguing extension of the Shuttle is an L-5er's dream come true — a passenger-carrying orbiter.

Yet to be determined, however, are specific space projects which would make these Shuttle design changes necessary. An encouraging sign is President Carter's space policy which does not preclude such Shuttle growth potential.

Leonard David is Director of Student Programs for the Forum for the Advancement of Students in Science and Technology (FASST).

NEWS BRIEFS

This summer the United Nations Committee on the Peaceful Uses of Outer Space will once again consider the Austrian draft of the proposed "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies". This draft of the treaty, if approved, may outlaw private enterprise use of the Moon or asteroids. At last year's June 26 through July 7 meeting on the treaty the U.S. delegation opposed those provisions. A new face that might show up in this year's round of negotiations is Kenneth S. Pedersen, recently named director of NASA's international affairs division.

Rockwell International was recently awarded a $1.9 billion contract to build two new space shuttle orbiters and refurbish two others. This cost-plus-award fee contract is one of the largest agreements in NASA's history.

UCLA is offering a 5 day course on "Space Shuttle - Payload Accomodations and Applications" June 18 - 22 at the University of Maryland University College. For details write to Registration Clerk, University of Maryland University College, Conferences and Institutes Division, University Blvd. at Adelphi Rd., College Park, MD 20742.

Boeing advanced planners are considering a private enterprise space shuttle operation.

The U.S. Dept. of Energy is sponsoring a conference on the impact of solar power satellites on astronomy May 23 and 24 at the Batelle Pacific Northwest Laboratory.

The Soyuz 33 craft launched April 10 failed to dock with the Salyut space station. Russian pilot Nikolay Rukavishnikov, 46, and Bulgarian copilot Georgi Ivanov, 48, reported a system failure in the maneuvering engine at approach. They made an emergency nightime landing 48 hours later, thanks to their Oms backup engine.

Ironically, the news of the aborted mission was broadcast on Soviet radio as fireworks were blasting in the sky in celebration of Cosmonaut Day, April 12. A total of 10 of the 27 Soyuz docking missions have failed. However, observers point out that this simply reflects a Soviet design philosophy that accepts high failure rates. The Soyuz 33 failure, while disappointing, is not a setback for the Soviet space program.

Funds to approve a 5th shuttle orbiter have been authorized by the U.S. Congress. The mothballed Enterprise may be outfitted for space, or, alternately, an entirely new orbiter may be built. The price tag for FY'80 will be $27 million.

The U.S Senate is expected to authorize $3 million for NASA's large space structures work. The Office of Management and Budget, Carter's penny pinching arm, has opposed the project.

Last year Rep. Richard C. Ottinger, (D-NY) was the major opponent of the unsuccessful push to appropriate $25 million for solar power satellite work. Stating, "My eyes have been opened," he has suggested that this year he may back the $25 million effort.

NASA's Marshall space center has awarded a $2.7 million solar array wing contract to Lockheed Missiles and Space Co. The solar array, measuring 105 x 13.5 feet will produce 12.5 kw. An experimental flight is scheduled for November 1980.

Announcements:

Conference for the 80s

An international futures convention, expected to be the largest ever held, will take place in Toronto, Canada, July 20-25, 1980. The event will be a combination of the Third General Assembly of the World Future Society and the fifth conference of the Canadian Association for Future Studies (CAFS). The theme of the meeting will be "Through the Eighties" with a focus on problems of world resources and common human values and goals for the near-term future.

Earlier themes of the World Future Society had a broader scope: "Dimensions of the Future" (1971) and "The Next 25 Years: Crisis and Opportunity" (1975). The current sharper focus on the decade ahead represents the general feeling that this will be a particularly crucial period of time. The 1980 conference committee stated: "As we enter the 1980s, the people of this world face more crises and problems than ever before. But the problems and dangers of the present should not blind us to the real progress that has been made or to the real opportunities which lie ahead."

Persons wishing to submit proposals for seminars, presentations or other participation in the conference should write to:

1980 Conference Committee
World Future Society
4916 St. Elmo Avenue
Washington, D.C. 20014, U.S.A.

Errata

A misquote appeared in the "Space Policy" article by Ken McCormick, **L-5 News,** March 1979. Dr. Frank Press was quoted as saying, "The era of 'one-shot spectaculars' is over, and the space program wll now proceed in an 'evolutionary' manner." Actually the only direct quotes from Press in this sentence were "one-shot spectacular" and "evolutionary;" the rest of the sentence was worded by the author.

Free Literature

NASA's Mailing List

Those persons interested in being placed on NASA's mailing list to receive the agency's News Releases can write to the following new address:

NASA
Public Information, LED-10
Washington, D.C. 20546

Lunar and Planetary Information Bulletin (formerly the Lunar Science Information Bulletin).

There are usually four issues per year, distributed free to lunar and planetary scientists, educators, students and their institutions.

Editor:
Frances B. Waranuis
Lunar and Planetary Institute
3303 NASA Road One
Houston, Texas 77058
(713) 488-5200, ext. 35

Air & Space Magazine

This magazine is published by the Smithsonian Institution's National Air and Space Museum and is issued bimonthly from September through May. Registration is free to individual educators, librarians, scientists and engineers interested in aerospace education, or affiliates of professional societies or non-profit organizations (such as L-5). Registration is permanent. State the reason that you qualify for free registration to:

National Air & Space Museum
Room 3569
The Smithsonian Institution
Washington, D.C. 20560

"Cities in the Sky"

The Robert J. Novens Planetarium of Ocean County College, New Jersey, is preseenting a program on space colonies entitled "Cities in the Sky." The show is set in the future and will "review" the first 100 years of space colonization and space manufacturing. The program will continue through June 24, and further information may be obtained by calling the planetarium at (201) 255-4144.

Your Ticket Into Space

Starlog/Future Life (S/FL) Magazines are pleased to announce that space is available aboard the first reusable vehicle into orbit—the Space Shuttle. S/FL has purchased room on the Shuttle, to be filled with a winning experiment or experiments from a nationwide "Getaway Special" contest now underway. In the current issue of **Future Life** (#10), now on sale at newstands, an informative article provides the best look yet at how to plan a project for the contest.

What pet idea, bright theory or burning question would you like to test in space? How will the zero-gravity of outer space affect biological processes? What new alloys might be created in the airless void above Earth's atmosphere?

The experiment(s) chosen will be fitted into a carefully designed container, which is attached inside the Shuttle cargo area for a round trip flight into space.

Who may enter? The opportunity is open to all individuals or groups regardless of planet of origin. Contestants can be students, professional biologists, artists, photographers, high school or college teachers, gardeners—anyone and everyone is eligible—with S/FL picking up the tab for the experiment's ride into space. The deadline is July 20, 1980.

To aid those submitting payload experiment ideas for consideration, S/FL, in cooperation with the Forum for the Advancement of Student in Science and Technology (FASST), is now offering a Space Starter Kit. The Kit includes information to acquaint contestants with the space "ground rules" for designing orbit-worthy experiments; a bibliography of selected space publications; a resource list of organizaitons and individuals who can help in designing ideas; update material on past and possible space experiments; and an overview of the Space Shuttle program and its various missions.

For the S/FL Space Starter Kit, and an entry form for the "Getaway Special" contest, send $3.00 to:

STARLOG/FUTURE LIFE
Getaway Special Starter Kit
475 Park Avenue South
New York, NY 10016

Inside the L-5 Society

New England L-5 on the Move!

The recently formed New England L-5 is starting out with a burst of activity. Their newsletter "Hubcap" reports preparations for Space Day and Space Week celebrations and the formation of a Liason Committee to establish relationships with outside groups and promote L-5 goals. Their chapter meetings have included such speakers as Dr. Arthur Kantrowitz, Dr. Philip Chapman and Mr. Christian Basler. The New England L-5 Chapter will soon be incorporated as a non-profit corporation in Massachusetts and will be electing officers. For information, contact:

Marcia Allen
29 Catherine Street
Roslindale, MA 02131

News Niagara Frontier

The Niagara Frontier L-5 Society has been accepted as an affiliate club of the Buffalo Museum of Science! We will have a public meeting the fourth Sunday of each month at the Museum. Come help us with exhibits, slide programs and our July Space Day celebration! Is there anyone out there in Albany? Ithaca? Potsdam? We'd like to share ideas, resources and moral support. Write to:

Mrs. Elissa Wynn
40 Kings Trail
Williamsville, N.Y. 14221
(716) 689-9140

L-5 in Miami

A miami chapter of L-5 is organizing! All those interested please call or write:

Miami L-5
c/o Ted Apelt
3010 NW 36 St. Ct. A135
Miami, FL 33142
(305) 633-2089

New Brunswick L-5

A new L-5 chapter has been formed in Fredericton, New Brunswick. The chapter is named Starover Fredericton and is an evolution of a newly formed science fiction and futurist club. The membership is diverse, ranging from junior high school students to professionals. For more information, contact the chapter coordinator:

Fred Brown
357 Montgomery Street
Frederickton, New Brunswick
Canada
E 3B 2X2
(506) 454-5319

Local Chapter Update

Flagstaff/NAU L-5 Society
Dr. Reed D. Riner, Faculty Advisor
Dept. of Anthropology
Box 15200
Northern Arizona University
Flagstaff, AZ 86011
Douglas Cosper, President
Jonh Benner, Vice President
Peter Hoffman, Secretary-Treasurer

Fresno L-5
36874 Cressman Rd.
Auberry, CA 93602
(209) 225-0768
Gale Smith, President
Eric Forster, Vice President
Chris Gudger, Secretary

Greater Phoenix L-5 Society
P.O. Box 635
Tempe, AZ 85281
Steven Mark Cohn, President
Katherine Blair Herman, Vice President
Katherine Blair Herman, Secretary
Steven Mark Cohn, Treasurer

L-5 Society Bay Area Chapter
814 Miramar Ave.
Berkeley, CA 94707
(415) 526-9346
Ross Millikan, President
David Brandt-Erichsen, Vice President
Jess Millikan, Secretary
Norm Albright, Treasurer

L-5 Society of Houston
P.O. Box 10161
Houston, TX 77206
(713) 491-1480/749-7555
Jimmy Rosamond, President
Dan Woodward, Vice President, City Coordinator
Margaret Adamson, Secretary
Michael Pelizzari, Treasurer
Clifford Carley, U.H. Coordinator

L-5 Society of Texas
Box 8213, UT Station
Austin, TX 78712
Ron Nickel, President
John Strickland, Vice President
Joseph Vissers, Secretary
R. J. Howe, Treasurer
Claudia Crowley, Communication Officer

Lehigh L-5
Box 441 Lehigh University
Bethlehem, PA 18015
(215) 691-6805
Pete Goldie, President
Barb Geekie, Vice President
Charles Peters, Secretary
George Lein, Treasurer

Niagara Frontier L-5 Society
40 Kings Trail
Williamsville, N.Y. 14221
(716) 689-9140
Elissa Wynn, Co-chairman
Michael Cooper, Co-chairman

OASIS
P.O. Box 704
Santa Monica, CA 90406
(213) 536-3209 (after 5 P.M.)
or (714) 554-0276
Terry C. Savage, President
Howard Gluckman, Vice President
Michael Thal, Treasurer
Charles Carr, Secretary

Raleigh L-5
Box 5381
Raleigh, N.C. 27650
(919) 779-2384
Tim Kattermann, Co-coordinator
Hubert Morris, Discussion/Projects Chair

Space Futures Society
3059 Cedar St.
Philadelphia, PA 19134
(215) 739-7780 (after 7 P.M.)
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Ron Smolin, Treasurer
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Upstate Space Alliance
78 Lattimore Rd.
Rochester, N.Y. 14620
B. Voris, President
Roy Craig, Vice President
DeWain Feller, Treasurer
Wendy Ng, Secretary

West European Branch L-5
45 Wedgewood Dr.
Poole, Dorset
BH14 8ES

United Kingdom
0202 730395 (phone UK)
Roger Sansom, Co-coordinator

The above chapters are officially affiliated with the L-5 Society. That is to say, they can legally make use of L-5's tax exempt status and nonprofit mail privileges. Also, a number of chapters not listed above operate under the aegis of some of these chapters and as a result also can take advantage of those privileges.

The following chapters are either recently formed, in the process of forming, or, by the time you get this list, may have already become officially affiliated groups.

Bristol, CT L-5
c/o Jordan D. March II
28 Trout Brook Rd.
Bristol, CT 06010

Finland L-5
c/o Ari Harenko
Valskarinkatu 1 B 43
00260 Helsinki 26
FINLAND

High Frontier Society
321 O.E.H.
University of Pittsburg
Pittsburg, PA 15260

L-5 Society, Boston Chapter
P.O. Box 162, Prudential Center
Boston, MA 02199

Maryland Alliance for
Space Colonization
c/o Gary Barnhard
4323 East-West Highway
Bethesda, MD 20742

Milwaukee L-5
3514 S. 17th St.
Milwaukee, WI 53221

New England L-5 Society
c/o Marcia Allen
29 Catherine St.
Roslindale, MA 02131

Blaine Atkins, President
Marsha Allen, Secretary
Mike Gerardi, Treasurer

North Carolina State L-5
c/o Robert Baldwin
Rt. 4 Box 121A
Waxhaw, N.C. 28173

Northwest L-5 Society
c/o Tom Buxton
928 18th Ave. W
Kirkland, WA 98033
or
c/o Hugh M. Kelso
550 Bellvue Way SE
Bellevue, WA 98004

Nova Scotia L-5 Society
c/o Dept. of Geography
Saint Mary's University
Halifax, N.S.
B3H 3C3 CANADA

Ohio L-5
c/o Steven Stein
570 Fairhill Dr.
Akron, OH 44313

Pioneer Valley/Five College Area L-5
c/o Eric Carlson
318 Lincoln Ave.
Amherst, MA 01002

Vancouver L-5
c/o Ms. Camile H. Dionne
51 S. Hendy Ave.
North Vancouver, B.C.
V7L 4C6 CANADA

VA Tech L-5
c/o Cindy Hartman, President
4038 West A. J.
V.P.I. & S. U.
Blacksburg, VA 24061

West Germany L-5
c/o Uli Lochner, Pfaffstr 16
7500 Karlsruhe 41
WEST GERMANY

Jacksonville L-5
c/o Prof. Jay S. Huebner
College of Arts & Sciences
U. of North Florida
Box 17074

Jacksonville L-5
c/o Professor Jay S. Huebner
College of Arts & Sciences
University of North Florida
Box 17074
Jacksonville, FL 32216

Hartfort, Connecticut L-5
c/o Jordan Marché
28 Trout Brook Dr.
Bristol, CT 06010

Letters

I enjoyed William Agosto's article on mining the Moon in the December issue. The thorough review in print of the possibilities and problems of mining and using lunar and asteroidal materials is the report of a 1977 summer study entitled "Summer Workshop on Near-Earth Resources," NASA Conference Publication 2031. Some copies are still available from Dr. Michael Duke, Johnson Space Center, Houston, Texas.

A number of related studies are now in progress, and some useful new documents can be expected to appear in 1979. There is a lot of room still for the technical creativy, before we have a chance to get to work.

James R. Arnold
La Jolla, CA

Please print this letter. I just finished reading O'Neill's **The High Frontier** and I have a question that needs to be answered.

O'Neill talks endlessly about swimming pools, lakes, large numbers of people growing plants, mining (which needs plenty of water) and manufacturing (also needs a great supply of water).

But nowhere in his book does he mention where all this water is going to come from to maintain these operations.

What are the costs of making it or transporting it?

Think of how much a modern city depends on a good supply of water?

San Francisco, for example has to buy water from the State of Idaho just to survive.

Being in space and being dehydrated doesn't sound very pleasant to me.

Rick Stoner
Longmont, CO

If lunar resources are used, hydrogen must be shipped from Earth and combined with lunar oxygen. If carbonaceous chondritic asteroids are used, water (up to several percent by weight) may be extracted by distillation. — CH

I find it strange that the November 1978 **L-5 News** article, "Russia's 'Guest Cosmonaut' Program", a commentary by Jim Oberg, questions the significance and purpose of the latest series of cosmonaut launchings. The purpose of this plan, at least as outlined by the U.S.S.R.'s Novosti press agency, is to develop a permanent space station accommodating 12 to 24 people by 1980. In view of no official U.S. plans for a permanent space station, and a manned space program dependent on the NASA space shuttle with flight periods of 7 to 30 days, I am concerned about your snubbing this Soviet effort.

According to information I have, which quotes East German sources, the Russian station would be assembled from modules by unmanned Soviet Progress "space tugs" which would be used to ferry goods into space. Cosmonauts would travel to space aboard the Kosmolyot, a re-usable spacecraft now in development, although present Soyuz-type manned craft would also continue in this operation. A 1980's Soviet space station could initially involve docking two Salyut stations nose to nose with a multiple docking adapter between them. Progress, Soyuz and Kosmolyot ferries could then dock at midship or at either end.

Aside from determining the threshold beyond which it may be unsafe to go, these long duration flights could be seeking data for medical purposes on such things as human muscle tone, the cardiovascular system, and loss of calcium from bones, which, in turn, will affect design of future space stations and the ferry craft. It is also reported that in their "space home cum laboratory" the cosmonauts have performed over 50 technological experiments to obtain semiconductors in the Splav and Kristall space furnaces. Making new materials of this nature under weightless conditions might be of particular importance to the electronics industry.

In addition to these activities, there are a couple of other significant items related to the Soviet flights which your article fails to mention or take into account. First, photos, for example, taken by Salyut 6 indicate a huge underground water reservoir in a now inhospitable desert area of Kayahlitan. Don't you think that this discovery might lead to large scale development in that region? Second, I wonder if you have thought of the possibility of our needing the Soviet "guest cosmonaut stunts" to save our own Skylab space station. Our space shuttle is expected to be making orbital missions by late 1979 but I understand Skylab's orbit might deteriorate before then. The Soviets have the hardware, the trained personnel, and apparently the budget commitment to rendezvous with Skylab and move it into safe orbit, if need be, before that time.

If we can use outer space as a means for peaceful cooperation among nations, we do not need articles demeaning such efforts.

William Mattison, President
Futuristics, Inc.
Glen Ridge, New Jersey

Read my article again, I have great respect for Soviet space technology and vision; I have contempt for political manipulation of space to deceive public opinion. The "guest cosmonauts", alas, seem to come from the latter motivation.
—Jim Oberg

I agree with Mr. Albanese (**L-5 News**, Dec. '78) that the ocean floor is a potential human habitat, but I think we'll be able to exploit it fully only after we have settlements in space. The vacuum of space is a warm environment, flooded with radiant energy. The ocean floor is dark and cold. Hence a settlement in space can be a net producer of energy, while an ocean-floor settlement would need to be tied in to some energy source.

Furthermore, space is utterly transparent. Its resources are on public display and may be prospected by anyone with eyes to see. The ocean floor is a murky mystery, with visibility often limited to a few meters. Locating and exploiting its undoubted mineral treasures is likely to remain an elusive goal for generations.

I think we may someday need temporary settlements on the ocean floor, like the motor homes used to house construction workers drilling oil in inaccessible places. The motivations for permanent undersea settlements are still obscure. I think it would be a mistake to divide our efforts between the sea and space, when the payoff from space is so clear and obvious and that from the sea is so moot.

Dick Crawford
Walnut Creek, CA

I have read the article by Hans Moravec concerning "Skyhooks" and anchored satellites (**L-5 News**, August, 1978) with great interest. However, in his article Mr. Moravec states that the "mass driver" concept does not offer any means by which payloads could be safely softlanded on the Moon or any other airless body. I can not accept that statement as correct. With a mass driver on the Moon and of sufficient capacity a payload can be launched to either L1,L2, L4 or L5 — or with the aid of a small rocket thruster for trajectory corrections, incorporated in the payload, into an orbit around the Moon. Simple ballistic analysis will show that the payload can just as easily travel in the opposite direction, i.e. from an orbit or from any of these Lagrangean points down to the "muzzle" of the mass driver. Since the Moon lacks an atmosphere and any gravity aberrations along the trajectories can be carefully measured, any trajectory disturbances would be few and small. Necessary trajectory corrections to counteract these disturbances and the scatter effect they cause could easily be provided by small rocket thrusters with great accuracy a system similar to the instrument landing system of aircrafts could be used, using beacons of microwaves or laser light as reference points. Similarly the initial launch down a trajectory of this kind could be made with very high accuracy using such a beacon as reference point. The payloads would, so to speak, home in to the mass driver like a "smart bomb". The mass driver would then work as an electrical generator to brake the speed of the incoming payload. The payloads and therefore the drivers would have to be of fairly large size of course and in the case of orbiting payloads the "landing mass driver" will have to point in the opposite direction relative to the launcher.

Doktor Claes-Gustaf Nordquist
Stockholm, Sweden

Your proposal is, of course, correct. My statement that the lunar mass driver provides no way of bringing payloads in was too dogmatic. I meant that the driver, as proposed, has no provision for slowing them down.

I do feel the practical difficulties are considerably higher for an electromagnetic catcher than for a skyhook transporter. Firstly, as you point out, the current proposals for lunar mass drivers, with 50 kg payload units and 1000 gravities of acceleration, would have to be scaled up considerably, making the total size very large. Secondly, the high accelerations would restrict the nature of the payload. Finally, the rendezvous with the end is at a relative velocity of 2.5 km/sec, and the required precision is very high, so the guidance will be difficult and the consequences of a miss occasionally very serious.

An optimum size Kevlar skyhook, on the other hand, masses only 13 times as much as its payload, and generates a maximum of 1/2 gravity. The rendezvous velocities are near zero. On the negative side, a skyhook sweeps out a large orbital area, and provides plenty of opportunities for collisions. Such a collision might be disastrous for the skyhook's payload.

A few picky details: regenerative braking is difficult enough that an electromagnetic decelerator might actually consume net electrical energy. The wasted power would show up as eddy current heating in various conductive parts, and resistive heat in the magnet coils and drivers. The inertial path from the Moon to L4 or L5 is not the same as the path in the reverse direction. To move from the Moon to L5, an object must temporarily move to a higher orbit than the Moon. To go from L5 to the Moon, it must temporarily drop to a lower orbit. This means the angles of arrival and departure are different at both ends.

The transportation problems in space are so ubiquitous and so varied that I'm sure most of the methods so far proposed (and many yet to be invented) will be used sooner or later.

Sincerely,
Hans Moravec
Stanford, California

L5 NEWS

June 1979

H. Keith Henson asks,
"Where are you Obi Wan Kenobi"
Ken McCormick reports on
Landsat hearings.

L-5 NEWS

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In this issue:

1 Space Forts or "Where are you Obi Wan Kenobi?" *by Keith Henson. Asteroid forts, laser and particle beam weaponry—what kinds of warfare could the future bring?*

4 When the Soviets Let Their Hair Down *Dick Fredericksen comments on the journalistic tendancies of the Soviet popular press.*

5 Energy from Space *by Iosif Zorich from the Soviet newspaper* **Nedelya** *(***The Week***). A flight with the Soviets to energy sources of the future.*

6 Shakespeare Quoted At Senate Hearings

7 Ariane Ahead of Schedule *by Randy Clamons*

9 The Landsat Hearings *Ken McCormick gives the latest on the progress of remote sensing systems legislation*

10 Hail Columbia *Space Shuttle Orbiter 102 prepares for takeoff. By Frederick H. Osborn Jr.*

11 High Frontier Politics *Ken McCormick voices his views on the importance of SPS.*

13 X-3 Shuttle Development *by Paul Geyer, TEI Astronaut Corps.*

14 News Briefs

15 4th Biennial Princeton Conference *by Frederick H. Osborn Jr.*

16 Announcements Inside the L-5 Society

17 Letters

Cover: Eric Drexler's high performance solar sail design. This sail might be developed with an investment as low as $100 million. (See "4th Biennial Princeton Conference" by Frederick H. Osborn Jr., page 15 of this issue.) Painting by William Hartmann

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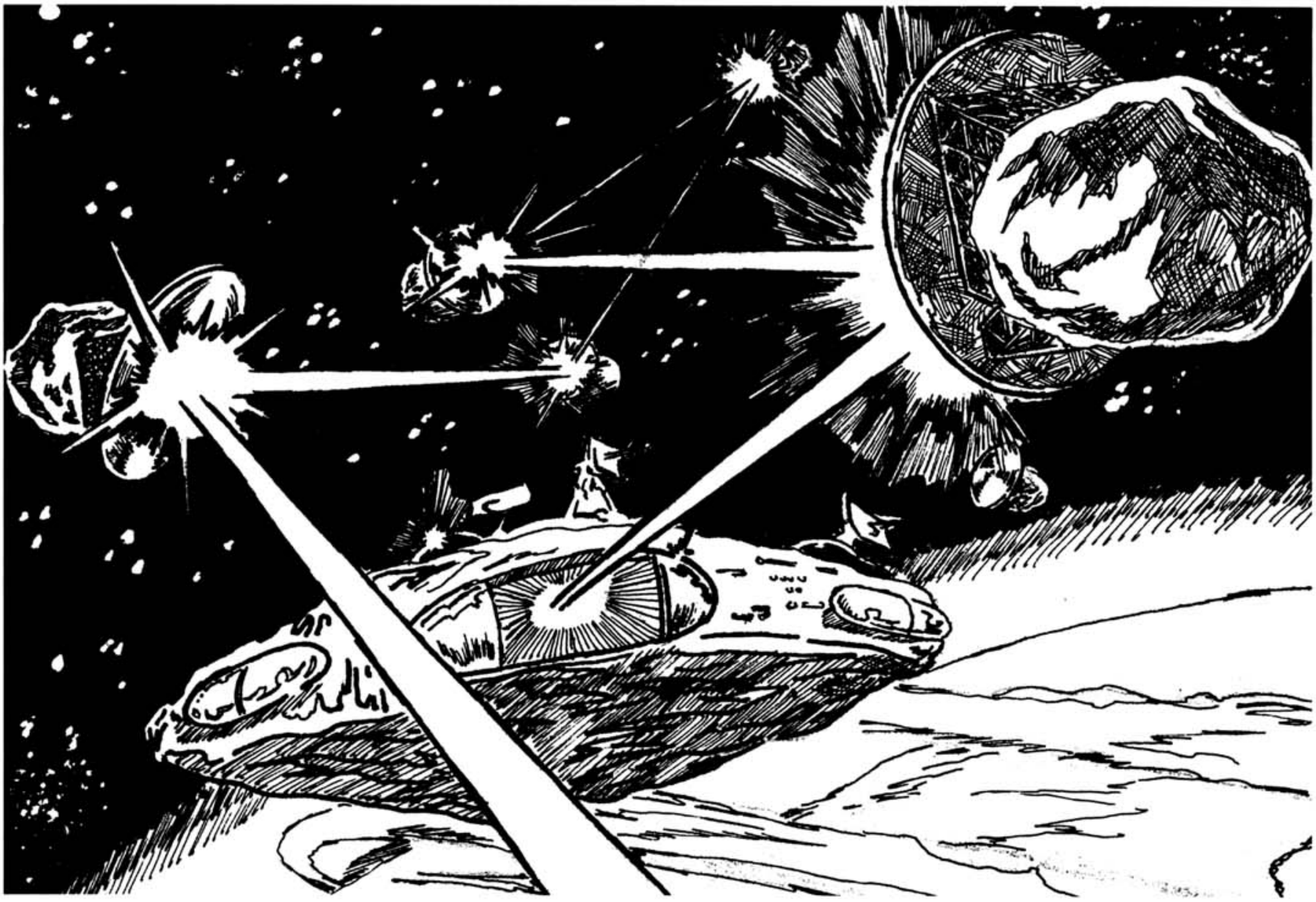


Artwork by James Babcock

Space Forts
or
"Where Are You Obi Wan Kenobi?"

by H. Keith Henson

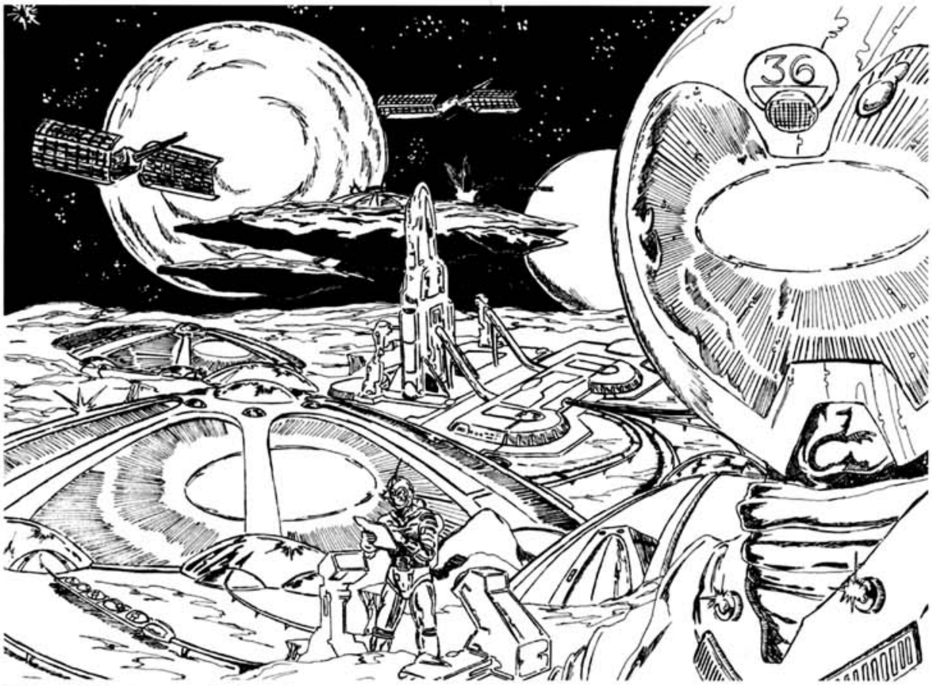
We who have grown up with the bomb can hardly imagine a world without the Sword of Damocles hanging over our heads by a thread. Strategic warfare has been dominated by offense for over 30 years.

Even though it might take 20-50 years, advances in space might swing the balance back toward defense. Here are some wild speculations, hopefully based on engineering realities.

Don't be too surprised if the Department of Defense picks up the slack in NASA funding of mass drivers and solar sails. A mass driver is just what you need to bring most of an asteroid to the vicinity of the Earth by throwing away part of the asteroid for reaction mass. Solar sails would bring them back piecemeal. A million-ton asteroid in high Earth orbit would solve a number of problems such as providing hardening for certain advanced weapons systems and their heat sinks.

"Hardening" is the capacity to take a beating and remain functional.

"Heat sink" is an engineering term which can mean anything from a tiny clip on a transistor to the Mississippi river. It's whatever is used to get rid of waste heat. On Earth, waste heat is mostly carried off by water or air and eventually radiated from the vast area of the planet into the cold (three degrees above absolute zero) universe. Some of you may remember the story by Poul Anderson about a rogue planet (Satan) that was thawed out by a close pass near a star and then kept warm as it sailed back into the dark by industrial



Artwork by James Babcock

waste heat on a grand scale. Getting rid of waste heat without a planet isn't hard, but it isn't cheap either.

Waste heat radiators are a major factor in the design of space industrial facilities, habitats, farms and military bases. For all of these including, in the long run, military bases, the Stefan-Boltzman law relating temperature and radiation rate and the fact that people and their machines function best around "room temperature" implies that the radiator surface area will be about four square meters for every, kilowatt of waste heat.

Military fact #1: in the size we need, waste heat radiators will be very large. Radiators must be filled with something (substitutes for wind and water) to carry the heat. For both physical and economic reasons radiators should have walls no thicker than required to contain the filling material.

Military fact #2: radiators are unavoidably fragile. Something both large and fragile would make a lousy military heat sink. Nobody can cheat on physical laws, but with an asteroid, you would be able (for a while) to use the "Alice's Restaurant Method" of waste heat disposal. Alice, who lived in the belfry of a deserted church and put the garbage downstairs, didn't have to take it out very often.

Two weapon systems, particle beams and lasers, have the potential to end the current offense-dominated Mexican stand-off referred to as "Mutual Assured Destruction," or MAD. (Someone in the five-sided squirrel cage has a sense of humor.) Lasers are getting substantial (about $200 million per year) development money in this country, and particle beams are believed to be better supported in the U.S.S.R. The April '79 issue of **Scientific American** has a disparaging article on particle beam weapons. A good part of their objections would not apply to asteroid-based weapons, but particle beams do seem to have more problems than lasers. (The article, while well worth reading, has some of the flavor of a 1900 essay on the impossibility of heavier than air flight.)

Both particle beams and lasers are line of sight, speed of light weapons. This could make for some mighty short wars! They are very similar in needing millions of kilowatts of power and large heat sinks (because they are not very efficient) and both work better in space. Either method, with enough power behind it and a good enough aiming system, could make short work of ICBM's, submarine launched ballistic missiles and perhaps even bombers and cruise missiles, thereby eliminating all three of the U.S. "triad" at one stroke. (Pretty neat, huh?) Since they are not "weapons of mass destruction" presumably they would not be banned by the 1967 Outer Space Treaty. (The U.S. and the U.S.S.R. are special cases as their ABM treaty binds them to not emplace space-based antiballistic missile weapons and strongly limits ground-based ABM's. The treaty was a smart move for both countries considering the cost (very, very high) to effectiveness (low) ratio of ground based ABM systems. If space-based weapons reversed this ratio, the treaty would certainly be revised, mutually or unilaterally.)

Skipping for a moment the moral and geopolitical implications, (you can make a good case supporting or opposing) how does an asteroid fit into this picture?

First, it's by far the easiest way to get a hardened site into space. Hardening is absolutely essential if the opposition has a similar installation. Otherwise, all the advantages go to "he who shoots first," a situation worse than MAD. An actively defended fort could most likely stop missiles, but there is no way to shoot down a laser beam. However, you need not worry about lasers if you are inside a multimillion-ton asteroid. An MIT study some years ago concluded that even to slightly deflect an asteroid (e.g. Icarus) would take a lot of the very largest hydrogen bombs people make. A laser sized to wipe out missiles would just blow little pock marks in the surface of an asteroid.

Second, to keep the laser cool you need a monster heat sink that a hostile laser won't cut to confetti. Radiators are just too vulnerable, (see above) so the waste heat will have to be stored till the war is over and that means an asteroidal sized mass to store the heat. Even if the laser gasses only make one pass through the laser and then are discharged into space, a substantial heat sink would be needed for the auxilliary equipment and such things as cooling the laser mirrors. For the same reason, all the energy to fight a war will have to be stored inside.

Both particle beams and lasers...could make short work of ICMB's, submarine launching ballistic missiles and perhaps even bombers and cruise missiles, thereby eliminating all three of the U.S. "triad" at one stroke.

If you were facing hostile lasers, diverting a solar power satellite (SPS) to power an antiballistic laser would not be a wise move. Besides that, geosynchronous orbit, the most likely place for SPS, may be higher than ideal for these weapons. It would be easier to hit missiles from a lower orbit, though recent studies claim that aircraft could be powered by laser from geosynchronous orbit. (Seven studies have been made on laser-powered aircraft concepts during 1974-1978; see "Laser Aircraft" **Astronautics & Aeronautics**, March 1979.)

How much energy storage and heat sink

capacity would be needed to fight a hypothetical war between the major powers with space based lasers zapping all the missiles? Unless you complicate things by having the forts try to fight each other to the finish, a few gigawatt hours of beam energy is sufficient to wipe out the warhead delivery systems inventory of the entire world. Altogether there are less than 5000 ICBM's and submarine-launched ballistic missiles. Five gigawatt hours of beam energy would give a little less than a ton of explosive effect for each one.

Because lasers are only about 20% efficient,* and allowing for some safety margin, energy storage might be ten times the beam energy and heat sink capacity about eight times the beam energy. To get a feel for this amount of energy in standard military terms one gigawatt hour is equivalent to about 900 tons of TNT.

The next question is how big an asteroid do you need in order to absorb, say, 40 gigawatt hours? A simple rule of thumb is that a kilowatt second will heat a kilogram of rock about one degree C. Forty gigawatt hours is 14.4 x 10^9 kilowatts, which means this much energy would heat a million ton (10^9 kg) asteroid 14.4 degrees C. Thermal stress rather than absolute temperature rise may turn out to be a determining factor. To keep a fort ready, you keep it cold.

How would an asteroid fort be constructed that could take considerable pounding from lasers and missiles and still be able to zap ICBM's? The best type, to start, would be the solid nickel-iron variety found in science fiction stories. Unfortunately, that may be the only place to find them. The processes (hotly argued over) that formed these objects may have left fracture-prone weak zones of silicate material between large blocks of solid metal.

For iron asteroids with fracture zones or stony iron (lumps of iron mixed with rock) the first job will be some outside shaping followed by drilling a lot of holes through the asteroid and stringing it together with steel cables. This would probably work with any asteroid that had as much compressive strength as concrete.

Next, a maze of coolant channels would be drilled through the rock or iron. Iron would provide an advantage here because of its much better conductivity. Either rock or iron would be fairly easy to drill through, but a mixture would be more difficult. The laser, control system and power storage would be installed in cavities dug out of the center of the asteroid. My guess is that energy would be stored in flywheels or fuel cells. Primary power could be nuclear reactors or solar cells. Either the solar cells or heat radiators for the reactor would hang outside and you could expect them to be shot off right at the start of any action.

Lastly, the surface would be covered many meters deep with foamed metal to soak up energy from a close nuclear blast or a short laser pulse. Much of the energy from a nuclear blast in space arrives in the form of X-rays which heat the outside surface so fast that a shock wave causes pieces to fly off the inside wall (spallation). A substantial layer of something crushable takes care of this problem.

How much energy storage and heat sink capacity would be needed to fight a hypothetical war between the major powers with space based lasers zapping all the missiles?

To track targets and control the aiming of the laser would require a dispersed phased array radar too spread out to knock out with missiles and too hard to take out quickly with a laser. Verification of target destruction and some tracking would be done optically or with infrared. The radar information would be transmitted over redundant channels to a very large, fast computer in the fort. This part is within the capacity of present day electronics.

Like the Death Star in Star Wars, these space forts would have a vulnerable spot. They could be really messed up if a tightly focused laser beam went in where their relatively diffuse beam went out. Each one might be surrounded with a flotilla of actively controlled mirrors. That way, a fort could take bank shots at the other forts, while avoiding looking directly at them. (A fully focused beam would be so energetic that it would not be reflected, but just vaporize the bank-shot mirror.)

There are many counter and counter-counter strategies including shooting lasers at the forts from the ground, trying to disable all the enemy's reflector flotilla, hardening the bank shot reflectors, and slinging rocks at the forts. None look very promising. Attacking from the ground with lasers looks like it would bankrupt the country that tried it.

Why? Missiles can by destroyed by the energy equivalent of a few kilograms of TNT. A bomber can be wrecked by the equivalent of a few hundred kilograms. But an asteroid would take hundreds of megatons of TNT or millions of gigawatt hours. Not counting laser inefficiency, or the cost of the laser, a million gigawatt hours at one cent per kWh is $100 billion. The lasers would cost a thousand to a million times this much. Hitting a fort with another asteroid would be effective, but would take years due to celestial mechanics considerations. Also, it isn't easy to do secretly. Even the slightest ability of a fort to dodge would make it vastly more difficult to hit.

Fighting it out between forts of similar size looks like a lost cause. The old saying "this hurts me more than you" really applies to space forts because four times as much energy as is in the laser beam must be dumped internally. The vast majority of energy coming in on a laser beam would be reradiated to space from where it struck and do very little heating. Even with limitless energy available, an attacker using lasers would cook itself long before doing much damage to a target fort.

For the same reason, a small amount of hardening would protect a ground installation from attack by a space-based laser. The total energy available within a fort due to laser energy storage is equivalent to only a few hundred to a few thousand tons of TNT. The opposition couldn't hide the size of a fort either. The potential destructive power of a fort would be directly proportional to its observable size.

Schemes to put forts out of action would be less attractive if many countries owned several forts each. If only two countries owned one fort each, a fort being put out of action would leave the owner of that fort in a very bad fix, exposed to ICBM's without any way to retaliate. If a dozen countries owned several forts each, there would be very little point in keeping ICBM's active at all. Of course, some countries would still keep ICBM's around just to force others to spend money on defense. (A major effect of the U.S. bomber fleet is to force the U.S.S.R. to spend a bundle on air defense.)

Whether or not asteroid forts and very large lasers in space would have a major effect on ground warfare is a good question. I am sure that tanks would be much more difficult to take out of action than cruise missiles or bombers. However, if the problems of shooting down through the atmosphere can be solved (adaptive optics won't work because of the distance to the perturbing media), it might accelerate the current trend, started by precision guided munitions, to quickly remove large, expensive objects from the battlefield. I don't think the troops will go back to swords and horses, but automatic rifles, hand-held rocket launchers and motorcycles might be the most expensive items practical on a year 2000 battlefield.

May the force be with you!

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*If you believe in higher efficiency, plug in your own numbers. Free electron lasers might reach 50%.

When the Soviets Let Their Hair Down

While Soviet remarks recorded at international conferences and in scholarly journals tend to be guarded, sometimes in the popular press the Soviets let their hair down.

by Dick Fredericksen

Regular readers of **L-5 News** should be experts, of sorts, on what to expect of the Soviet space program. By a casual count, there were five full-scale articles, two commentaries, three news items, and sixteen snippets that bore on this subject in the period from January, 1978 through March, 1979. Jim Oberg and Phill Parker gave technical details of the Salyut-Soyuz program. Tom Heppenheimer allowed that the Salyut-Soyuz hookup qualifies (like Skylab before it) as a "space station"; while Oberg, pulling the evidence together, concluded that the Soviets mean business about human activities in space, and that something BIG is in the works.

As for the Soviets' own representation of what they are about, Jim Oberg provided a long series of translations from the Soviet press, scientific reports, etc. Frederick Osborne, Jr., also conveyed some remarks made by Soviet scientists at an international astronautical conference. An overall summary is that Soviet scientists are cautiously optimistic about space industrialization and solar power satellites. One Soviet scientist has even taken the "O'Neill line" with respect to the use of lunar resources.

However, the remarks recorded at international conferences, in scholarly journals, and the like are understandably rather guarded. L-5 readers may be interested to learn that sometimes, in the the popular press, the Soviets let their hair down. The accompanying article from **Sputnik** magazine ("Energy from Space") is a spectacular case in point. (**Sputnik**, a digest in form and content, cites **Nedelya—The Week**—as the original source.)

A number of observations are worth making. First, note the almost lyrical quality of the description. "To it (the microwave beam from the power satellite), neither the cold of space, nor the thickness of the atmosphere, nor fog, nor dark storm clouds will be an obstacle. It will operate uninterruptedly, day and night." Gosh, remember the U.S. Postal Service?

Secondly, note carefully the list of environmental concerns: "How will the transmission of microwaves impact radio communications?" That's only given as one example of such a concern, but still it seems a significant choice, by way of what it doesn't put foremost. *What about the microwave safety issue?* Soviet safety limits for human exposure to microwaves (.01 milli-watts/cm^2) are more exacting than the United States standard (1000 times higher), and have been frequently cited by those in America who feel an anxiety about microwave proliferation. Notice, though, that at least one Soviet writer doesn't let the microwave willies temper his enthusiasm for SPS (or SKES, as the Russians designate it). There may be more than one school of thought about microwave safety in the USSR as well as in the U.S. Or, it may be that the Soviets do not intend their industrial safety standards to be applied unconditionally (to the exclusion of large-scale economic benefits) or out of context (in a roped-off receiving area).

Scan an article about marshlands, and you'll learn of schemes to make the northern rivers run backwards . . . . Soviet Communists have a fondness for this sort of thing: they love to raise visions of technological revolution . . . .

There is only one surprising note in what otherwise reads like a familiar litany: the allusion to "the bowl of a receiving antenna with a diameter of one kilometer or a bit larger." Bowl? Most of us had been envisioning something more like a field of waving dipoles.

A word of caution is in order. An American reader, knowing that the Soviet press is carefully censored, may infer too much from the publication therein of a pro-SPS article. It may seem to carry official approval. Or, deeply suspicious of all things Soviet, the American may see the article as "disinformation"—a put-up job to mislead Western readers. Either way, the impression could be heightened in the present instance by the fact that the article was reprinted in **Sputnik**, the USSR's slickest propaganda export. Nothing appears there, it is reasonable to assume, without thorough review.

A more relaxed appraisal, however, is available: *scientific bigthink is a fully approved literary genre in the USSR*. Pick up a children's book about transportation in a Soviet bookstore, and you're likely to find (somewhere toward the end) a breathless prediction of hovercars and levitated trains. Scan an article about marshlands, and you'll learn of schemes to make the northern rivers run backward. Read something about space, and—well, you get the picture. Soviet Communists have a fondness for this sort of thing: they love to raise visions of technological revolution, especially if vast public enterprises are required.

How seriously to take it? Well, it's not a commitment for delivery in the second quarter of 1983. Neither resources nor prestige are laid on the line by the mere fact that the Soviets let their hair down and talk about projects that appeal to them. On the other hand, neither is the discussion frivolous; the censors would be unlikely to pass a similiar article that encourages hopes of, say, telekinesis or precognition. The fact that the grandiose vision is published does imply a judgment that it's a reasonable scientific speculation. The fact that the Soviets are pouring resources and efforts into human occupancy of space does say something. And the Soviets do embark upon large-scale projects with long-term payoffs; it is in fact their favorite sort of project.

This article from the Soviet newspaper **Nedelya (The Week)** *exemplifies what Dick Fredericksen terms "scientific big think . . . in the USSR." (See the preceeding article, "When the Soviets Let Their Hair Down," by Dick Fredericksen.)*

Energy from Space

The creation of the orbital system "Salyut-Soyuz," serviced by automated space freighters, opens the way to construction in the cosmos of varied objects, among them orbital power plants.

by Iosif Zorich

The power of the Sun exceeds by 5,000 times the total power of all other sources of energy on Earth. And that source is inexhaustible. However, on Earth the Sun's rays scorch all living things in some regions, while in others they don't peep in for months. But even in the Sahara and Kara-Kum deserts, the Sun disappears nightly for half of the 24-hour cycle. Small wonder, then, that up until lately scientists have treated solar technology without much enthusiasm as an industrial resource for electric power generation.

But there *is* a place where the Sun shines constantly. That's in the open cosmos. There, there's no sunshine or sunset, no clouds, no atmosphere to weaken the sunshine. And now scientists of many countries are arriving at the thought that it's necessary to capture the Sun's energy precisely in space, and send it to the Earth. But is this possible? Yes, it's possible, and if not immediately, then in the not so remote future.

Already today they put photovoltaic panels on satellites and spaceships. These transform solar energy into electricity and feed with it the apparatus and auxiliary engines of the ships. Imagine a space station in so-called geostationary orbit; that is, at a distance of 35,800 kilometers from the Earth. The period of revolution of such a station is 24 hours; it will revolve synchronously with the Earth's rotation. The station will seemingly "hang" over one point of the Earth's surface. Geostationary, or synchronous, orbits are nothing new; in them are found communication satellites, with the help of which telegraph-telephone communications and long-distance television transmission are realized.

Artwork by James Babcock

At such a height, every square meter of the spaceship's panels can constantly receive from the Sun about one and a half kilowatts; from them it is possible to transform roughly a tenth part into electricity. One hundred and fifty watts from a square meter: that, to be sure, isn't much, but then, there's as much free space as you like in the cosmos. There's nothing to prevent spreading panels for tens of kilometers and receiving from them millions of kilowatts of energy. It is calculated that if a solar cosmic electrostation (SKES) is furnished with a pair of wings measuring 6 by 5 kilometers each, then the output of electricity will be 5 million kilowatts.

There is also another way to transform solar into electrical energy: thermal turbines. It is possible to gather solar rays with gigantic mirrors, concentrate the powerful beams, and use them to heat a liquid, turning it to steam. The steam will work in the ususal way: turn a turbine, with which a generator is connected, producing electrical current.

Fantasy? No, Reality!

However, there arises a problem of transporting the electricity to Earth. Not along wires, that's for sure! Two means of transmitting power over long distances without wires are being proposed: the first with the help of a laser beam, and the second—microwaves. The second, perhaps, is the more practicable.

Microwave technology has developed broadly in recent decades. It is precisely in this centimeter wavelength range that they carry out the observations of radioastronomy and implement high-frequency radio communications. The possibility of industrial transmission of large quantities of electricity via microwave channels is also under investigation. The first ideas in this area are attributed to the distinguished Soviet physicist, academician Peter Kapitsa.

This capacity promises humanity enormous benefits: it will be possible to pump electricity along waveguides—pipes laid under the ground like oil and gas pipes. But that's in terrestrial circumstances, whereas for the transmission of electricity from space, even pipes will be unneeded. A microwave bridge with a span of tens of thousands of kilometers will unite the SKES with the planet. To it, neither the cold of space, nor the thickness of the atmosphere, nor fog, nor dark storm clouds will be an obstacle. It will operate uninterruptedly, winter and summer, day and night. On Earth, the bowl of a receiving antenna with a diameter of one kilometer or a bit larger will be able to take the microwave radiation, transform it to the usual AC or DC current, and distribute this energy to consumers.

Fantasy? No! Grandiose as it is, such a project is based upon the practical ground of calculations and experiments. Such figures, for example, characterize the scale of the project. The weight (more accurately, the mass, since we're talking about conditions of weightlessness) of all the equipment of an SKES with a capacity of 10 million kilowatts, using photoelectric cells, comes to about 35 thousand tons, while for an SKES using turbogenerators, it's more than 100 thousand tons. All these materials, assemblies, and modules will have to be conveyed to space, mounted, tested, and set in operation. The assembly of such a station will be carried out in near-Earth orbit, located at a distance of 200-300 km from Earth, with the help of people and special robot-manipulators. After assembly and check-out, the plant can be conveyed to geostationary orbit. Hundreds of engines, placed along all areas of the station, are turned on, and it begins a cosmic trip stretching tens of thousands of kilometers. On that trip, half a year will go by, probably, or maybe a whole year. The station will need auxiliary engines even in geostationary orbit. They will orient the solar cells toward the Sun, compensate for displacements arising from the action of the "solar wind", and assure a strict orientation of the station relative to the receiving antennae on Earth.

Granted, a multitude of problems remain to be solved before it will be possible to set about creating space electrostations. But all of these have technical, rather than a principled character. However, there is an obligation to examine also the economic, social-legal, ecological, and other aspects of SKES creation. How, for example, will the transmission of powerful microwaves impact radio communications? How to distribute sections of geostationary orbit among countries and guarantee equal rights and equal opportunities for all countries?

"Shuttle" Ships in Space

And now we raise a question, paradoxical at first glance, nullifying everything said above: is it necessary to transmit energy from an SKES to Earth? Under terrestrial conditions, it's often easier and cheaper to transport raw materials than energy. Mightn't we take the same route in space? Might it be more expedient to build enterprises in some fields right in orbit, in a single complex with SKES? "Shuttle" transport ships will convey raw materials out and bring back processed materials, or even finished goods; passenger runs will transport service personnel, working in shifts. That will yield a mass of advantages.

First and foremost, it will significantly reduce the outpour into the Earth's atmosphere of the byproducts of the "dirtiest" productive processes. In the second place, in space, under conditions of weightlessness and almost absolute vacuum, it's easier than on Earth to obtain especially pure substances or materials with uniform distribution of dopants, and to grow large cyrstals with given properties.

Soviet cosmonauts have laid down the beginning of a space technology which, beyond any question, will develop and be perfected, crossing from the realm of experiments into the realm of industrial exploitation. The Soviet "Soyuz" space ships and "Salyut" orbital space stations not only serve the here-and-now needs of science and the national economy, but in no lesser degree work for the future of humanity. And one of the pressing problems in that future will be the opening up of an energy frontier in space.

Shakespeare Quoted At Senate Hearings

Reprinted from L-Forum, the Newsletter of the Northwest L-5 Society.

The February 12 and February 19 issues of **Aviation Week and Space Technology** contain editorials that will be of particular interest to L-5 members. They are taken from testimony by James Michener before the Senate space policy hearings, and from an address by Norman Cousins before an AIAA space policy panel. Both men eloquently defend space exploration as imperative to the growth and evolution both of the nation and of the human race. Michener's theme is primarily a historical perspective and a warning on what happens when a nation loses the "energy and commitment to lift it into the next cycle of experience." He offers a most apt quotation from William Shakespeare:

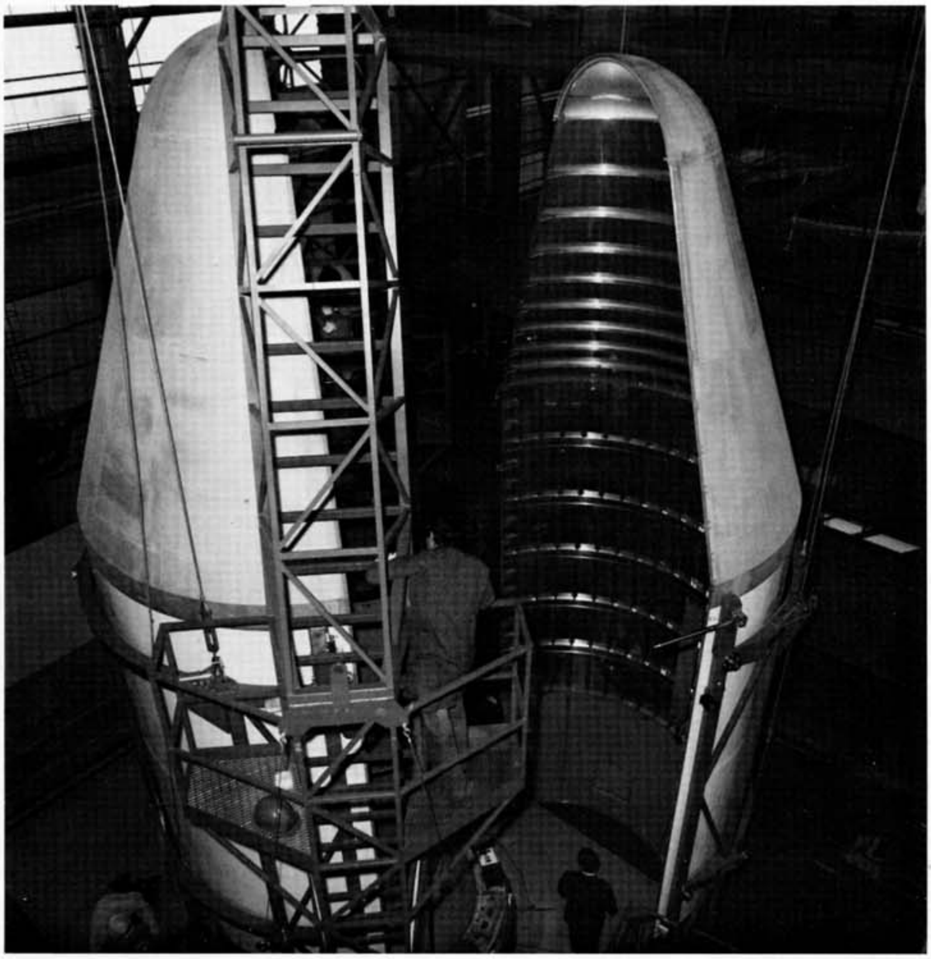
> There is a tide in the affairs of men,
> Which, taken at the flood, leads on to fortune;
> Omitted, all the voyage of their life
> Is bound in shallows and in miseries.
> On such a full sea are we now afloat,
> And we must take the current when it serves,
> Or lose our ventures.

Cousins sees the issue of space exploration in terms of the conflict between "those who have a constricted view of human potentialities and those who define infinity as that which takes place in the human mind." He perhaps oversimplifies things, but still makes a point. Where Michener quotes Shakespeare, Cousins quotes Whitehead:

> There is now no choice before us. Either we must succeed in providing a rational coordination of impulses and the guts, or for centuries civilization will sink into a mere welter of minor excitements. We must produce a great age or see the collapse of the upward striving of the race.

Ariane Ahead of Schedule

by Randy Clamons



Workers prepare Ariane fairings for testing at the Aerospatiale plant in Les Mureaux, France. (Photo courtesy of ESA)

ESA Sets Launch Date

The European Space Agency (ESA), a combined effort of fifteen countries mostly in Europe, has nearly completed the qualification firings of all three stages of the Ariane launch vehicle. An explosion caused by the faulty ignition of an engine at the end of November, 1978, which damaged the third-stage propulsion bay, has suspended developmental testing of this stage with flight tanks.

ESA does not feel as though this jeopardizes the project and will continue testing the third-stage with battleship tanks through June of this year. These tests will be carried out simultaneously when testing of the flight tanks resumes in May.

The Ariane launcher, originally designed to place a 1500 kg payload in a transfer orbit of 200/36,000 km, is scheduled to make four test flights between November 3, 1979, and October, 1980, well ahead of the initial program target. The first operational launch has been requested for April, 1981.

The first of the test flights will carry only the technological capsule and ballast. The other flights will carry a radio-amateur satellite (Amsat), a Max Planck Institute experiment (Firewheel), a European meterological satellite (Meteosat-F-2), an Indian experimental communications satellite (APPLE), and a European maritime communications satellite (MARECS-A). The Ariane launcher has the capability of placing two satellites in orbit from the same launch.

Upon completion of the tests the ESA plans to begin production of the Ariane launcher. Including space systems to which Europe is already committed and systems expected to be implemented, ESA projects a requirement of 40 to 50 launch vehicles over the next ten years.

Ariane to Compete With Shuttle?

Even though both the Ariane launcher and the Shuttle will be used to launch applications satellites, the uses of the systems could differ greatly. The Shuttle seems suited best to low orbit missions, since it requires an additional powered stage to reach geostationary orbit (GEO). The lift-off mass of the Shuttle to GEO is ten times that of the Ariane, but it performs only twice as well. Ariane is particularly suitable for the sun-synchronous orbits required for Earth observation satellites.

All three of the complete flight configuration tests of Ariane's three stages took place in December, 1977, and January, 1978, at nominal thrust. The first test of the Shuttle main engine at the beginning of the year was unsuccessful. The failure of one of the four Ariane qualification tests, says ESA, would have little impact on its operational availability. ESA, in view of the planned use of a single Orbiter for all six qualification flights of the Shuttle system, claims that one in-flight accident could be catastrophic to the NASA program.

The cost of launching satellites with the Ariane system is slightly less than the cost of the Shuttle launch. A satellite of the Intelsat V class could be launched, according to NASA, for 22.5 million dollars (mid-1977 prices). The marginal cost of a similar Ariane launch is very close at 22 million dollars (mid-1977 prices), which includes 10% for an insurance policy that provides a free reflight in the event of a failure.

ESA does not feel as though the Ariane and the Shuttle will compete for the satellite launch market. In the words of an ESA report, "It is fair to assume that the coexistence of Ariane and the Shuttle on the applications satellites market of the next decade should not prove detrimental to either system."

The Ariane will be used only for launching information retrieving satellites, while the Shuttle is designed to be piloted and re-usable. This will mark the true difference of the application of the two systems. Proposed plans to uprate the Ariane system include a reduction of production costs, raising the capability of the launcher to 2300 kg and a study of parachute-aided re-use of the L140 first stage.

ESA and NASA Combine Efforts

The most important program on which ESA and NASA cooperate is Spacelab, an inhabited re-usable space laboratory designed to be placed in orbit by NASA's Space Shuttle. The two agencies share equally the energy and crew time of this mission scheduled for 1981. ESA ordered the manufacture of the first flight model in March, 1978.

Spacelab is being built modularly to provide greater flexibility in its use. This system uses a module-pallet configuration as well as modularized subsystem elements. This will allow a greater payload by eliminating the unnecessary equipment, assuring dynamic design possibilities for future missions.

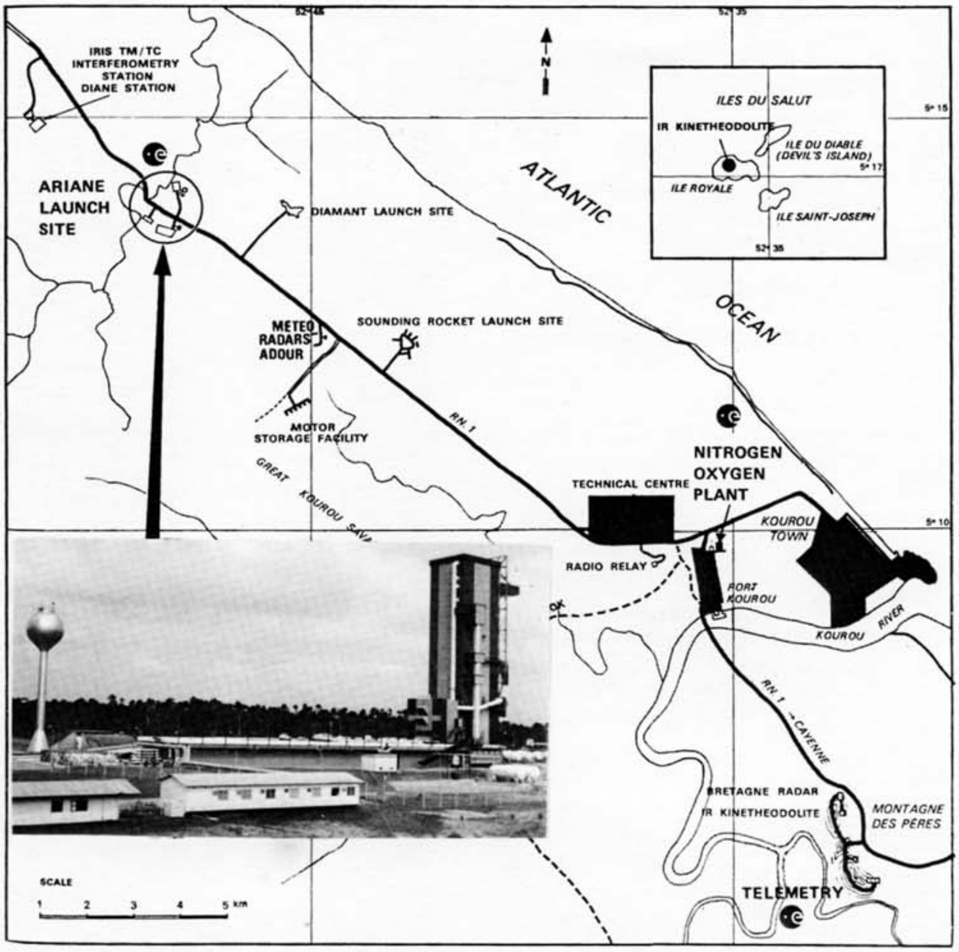
ESA and NASA have chosen 76 scientific and technological experiments — 60 European, 15 American, and one Japanese. The main advantage of this mission over those previous will be the presence of trained scientists as well as astronauts.

Some possible fields of experimentation include:

- High energy astrophysics
- Ultraviolet, optical, infrared and X-ray stellar, planetary and solar astronomy
- Atmospheric, ionospheric (plasma) and magnetospheric physics
- Life sciences (including biology, biomedicine, behavior)
- Remote Earth-sensing (meteorology, land-use, planning, resources, pollution control, etc.)
- Material sciences (e.g. crystal growth, pure metals and alloys, composite materials and fluid physics)
- Processing and manufacturing in space (e.g. electrophoresis, high-strength materials)
- Communications and navigation

Some 222 investigators from 16 countries will participate in Spacelab's first mission. Approximately 135 of the investigators are from twelve European countries (Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom), and 81 are from the United States.

The final launch date of Spacelab now depends mostly on the development of the Space Shuttle.



The Ariane Launch Site, situated within the Guyana Space Center.

Guyana Space Center

Launchings of the Ariane will be from the Guyana Space Center ("Centre Spatial Guyanais" — CSG) in Korou, French Guyana. This space was chosen by the European Launcher Development Organization in 1966 because of its equatorial location. At 5.23 degrees North, 52.75 degrees West, CSG is an advantageous location for launches into synchronous orbits. Since becoming operational in April, 1968 CSG has been responsible for the launching and the tracking operations of 12 satellites and about 350 sounding rockets and balloons.

Telemetry reception facilities include three stations of CSG and two cooperating stations, a Brazilian station near Natal, Brazil, and the NASA/DOD facility on Ascension Island. The Galliot station at Korou, the Montabo station near Cayenne, French Guyana, and mobile station to be located near Belem, Brazil, comprise the CSG part of the network. Tracking stations are at Meteo, Korou; Leblond, Korou; Montabo, Cayenne; Natal and the DOD station on Ascension Island.

Since the highly successful completion of the Diamant BP4 launcher program in September, 1975, CSG has been mainly oriented towards making adjustments to accomodate the Ariane program requirements. The Ariane facilities and launch site are owned by the ESA, whose member states have contributed some 70 MAU (million accounting units, 1AU = $US 1.08) to the cost of running and renewing the range. ESA participates in the planning, financing, and control of CSG through an agreement signed with the French government on May 5, 1976. This agreement guarantees ESA and its member states access to and use of the Ariane launch site for purposes of the program.

The Landsat Hearings

by Ken McCormick

Schmitt and Stevenson's legislation for a remote sensing operational system has won support from federal agencies, but Carter is still dragging his heels.

At an April 9, hearing on remote sensing, presidential science advisor Frank Press told members of the Senate Subcommittee on Science, Technology and Space that the Carter Administration is "committed" to moving experimental Earth resources remote sensing satellite programs to an operational system. But he maintained that uncertainties about how to establish an appropriate institutional framework for acquiring and distributing remote sensing data dictate that the Administration will have to spend more time studying the situation before taking action. Senators Harrison Schmitt and Adlai Stevenson III did not agree.

Remote sensing satellites provide useful data for such things as . . . the locating of mineral resources such as oil, gas, and coal.

Schmitt said at the end of the hearings on April 11 that "everybody agrees, except for the Administration witnesses, that we ought to act now. We've studied this thing to death. Anybody who's been in this business for any length of time at all believes that we've been at dead center for many, many years."

Sen. Stevenson pointed out that two years ago, when the subcommittee had considered legislation to establish an operational remote sensing system, Dr. Press had said that plans for such a system were premature and had promised that a cabinet-level group would study the issue and make recommendations. Stevenson said that the issue has since been studied by a number of groups, and that none had proposed further delay.

Federal agencies which were prepared to support legislation authored by Harrison Schmitt and Adlai Stevenson for a remote sensing operational system had been ordered by Carter's Office of Management and Budget to only go so far as to express a desire to work with Congress in the future to arrive at a satisfactory arrangement. This prompted Stevenson to say that "everyone in the Carter Administration wants to get on with remote sensing except one person — Carter."

"It appears," said Stevenson, "that the Congress is more ready to solve the institutional question than the Administration. If there is much more delay, we will legislate an end to the apparent indecision in the Executive Branch."

Remote sensing satellites provide useful data for such things as large area crop inventory, urban planning, forestry, water quality assessment and planning, flood control, surface water inventory, and the locating of mineral resources such as oil, gas and coal. The cost, time and labor required by more conventional techniques for gathering this data are often prohibitive. Sen. Stevenson has estimated the potential market for satellite data at one-half to one billion dollars in the early 1980's.

Daniel J. Fink, General Electric vice president, appeared before the subcommittee to support Sen. Stevenson's bill, but to express serious doubts about Sen Schmitt's bill to set up a private corporation for Earth resources information which would be modeled after Comsat. "I have taken the position," said Frank, "that what was good for the communications business with its long-established markets, mature user operating practices, and accepted international agreements, would most likely be bad for Earth resources observation, a new, untried venture with technology and markets that are still developing and proliferating." Fink preferred the approach of Sen. Stevenson, who would locate the service within NASA for a transition period of no more than seven years, after which the service would move to the private sector or some other agency or be left within NASA.

Schmitt argued that the private sector approach would be viable from the beginning because the government would be the purchaser of most of the data at first, and that this economic guarantee would allow sufficient time for the corporation to do the work of aggregating and developing for the non-government market. Schmitt acknowledged uncertainties about establishing the intrinsic value of the data, setting rates which will not exclude data acquisition by certain users, how to tailor the service to user needs, and how to provide enough redundancy for reliability of continuity of data. He maintained, however, that these questions would never be completely answered as long as the service were left within the government as an operational unit.

"It appears," said Stevenson, "that the Congress is more ready to solve the institutional question than the Administration."

Sen. Stevenson said that although he

feels that NASA is the best lead agency, we should be moving "under a congressional mandate towards operation by the private sector . . . I would like to see as much involvement as possible, and as early as possible, by the private sector, and still contemplate, in whatever the interim period is, operation of the system by the private sector."

Dr. Robert K. Vincent, president of Geospectra Corporation, a small company which now provides remote sensing services utilizing satellite data from the government, felt that if the U.S. is to maintain its lead in this technology, a compromise version of Schmitt's and Stevenson's bills must be passed as quickly as possible. Vincent expressed a desire to see, as soon as possible, a transition from a government operation to a corporation such as that described by Schmitt because "industry's profit motive and competitive nature will assure better performance than any government agency or non-profit institution."

John L. McLucas, executive vice president of Comsat Corporation, proposed a compromise approach in which Comsat would be designated as the entity responsible for the establishment of the remote sensing data service. Under the plan, NASA would continue the already-approved Landsat programs, and Comsat would contribute a satellite system to provide high-resolution stereoscopic data.

Although the White House says that assessments of how to proceed with an operational system should be completed this summer, Senators Schmitt and Stevenson both feel that it is necessary to continue pressing Carter on this matter in order to get any action. Said Stevenson: "I think after hearing the testimony from the Administration, that the only way we'll get it to act is to act ourselves. That means . . . (reporting) a bill soon from the Commerce Committee, and perhaps withholding action on the Senate floor until such time as the Administration will act . . .

"We've waited a long time already. I think it would be irresponsible for us to wait any longer.

"The Congress in a sense is ready, and the institutional problems, at least in the interim, should not be very difficult for anybody to resolve.

"So we ought to go ahead and do it. And if they (in the Administration) want to join us, that'll be their opportunity. They'll have a chance to do it.

"If they don't, then the Congress will have the opportunity to act early in the next session, at the latest, and I'd be very surprised if it didn't."

Hail Columbia

by Frederick H. Osborn Jr.

GARRISON, New York, April 6, 1979—(after a visit to Kennedy Space Center, Cape Canaveral, Florida, March 6, and several subsequent phone conversations with Dick Young, Public Information Officer at KSC.)

Columbia, Space Shuttle Orbiter 102, rollicked into Cape Canaveral, Florida, March 24 at 11:03 a.m. two weeks late. Patched and band-aided like a debutante dragged through brambles, she rode her sleek 747 to a gentle landing, heard welcoming speeches by Dr. Robert A. Frosch and other NASA notables in front of her crew, headed by John W. Young and Robert L. Crippin, and 3750 Kennedy Space Center employees, and was hooked up to the nearby demate device where technicians labored lovingly the night through. By 6 a.m., dismounted, wheels solidly on the ground, she was hauled away to the Orbiter Processing Facility for a full scale physical exam.

Her forward reaction control system will be checked out at Kennedy's Hypergolic Maintenance Facility this month (did you know that hypergolic means "igniting upon contact of components without external aid"?). Her right and left orbital propulsion systems will be similarly checked out in May.

Electronic and avionics experts will check her computers. Mechanics will test and install the three mighty main engines that are due to arrive April 10, April 29 and May 15, and 400 specially trained Rockwell technicians will work around-the-clock to finish clothing her tender underparts with 7,800 more thermal protection tiles.

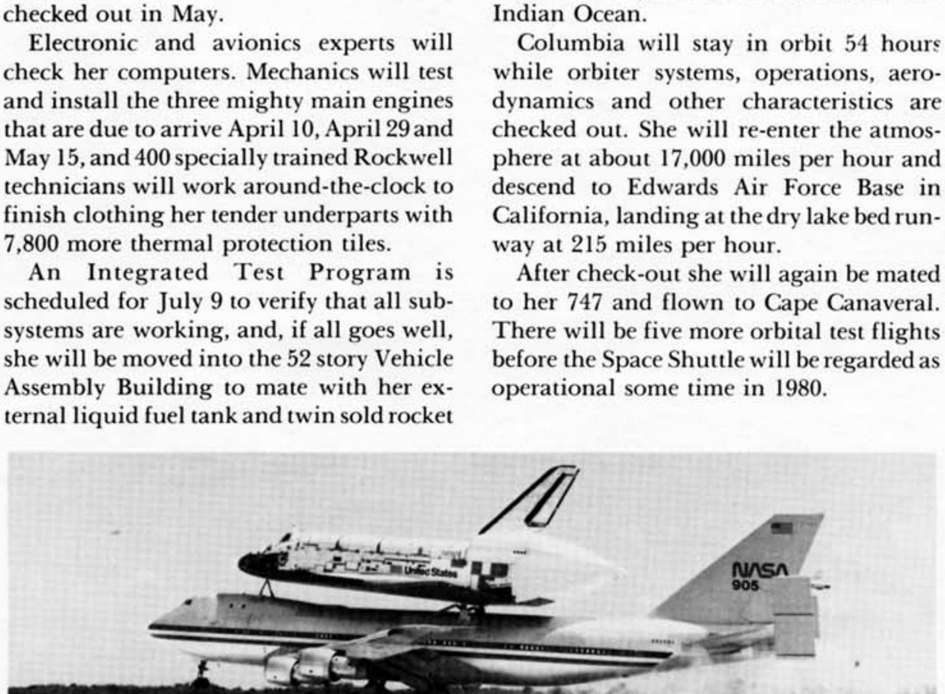
An Integrated Test Program is scheduled for July 9 to verify that all subsystems are working, and, if all goes well, she will be moved into the 52 story Vehicle Assembly Building to mate with her external liquid fuel tank and twin sold rocket boosters July 30th. After further testing roll-out to the pad at Launch Complex 39-A is scheduled for August 20. Testing and processing at the pad will take about 12 weeks. Engines will be tried out, flight and ground crews will conduct dry runs. The final check-out is scheduled for November 2, leading to a November 9 launch.

With Columbia's arrival, the corridors in the great KSC headquarters building, which for the past several years have echoed hollowly to skeleton crews rustling papers at each other, are bustling again. As if with returning spring, the air is becoming electric. Would that a whiff of this enthusiasm could be wafted to the White House and NASA headquarters in Washington!

It is expected that Columbia will be launched on her maiden voyage in daylight from pad 39-A into a 172.5 statute mile (277.5 km) circular orbit with an inclination of approximately 40.5 degrees. On reaching an altitude of 30 miles (48 km) her solid rocket boosters will drop off, parachute to the ocean 150 miles off Cape Canaveral and be towed back for refueling. About 69 miles up the external liquid fuel tank will be jettisoned and fall into the Indian Ocean.

Columbia will stay in orbit 54 hours while orbiter systems, operations, aerodynamics and other characteristics are checked out. She will re-enter the atmosphere at about 17,000 miles per hour and descend to Edwards Air Force Base in California, landing at the dry lake bed runway at 215 miles per hour.

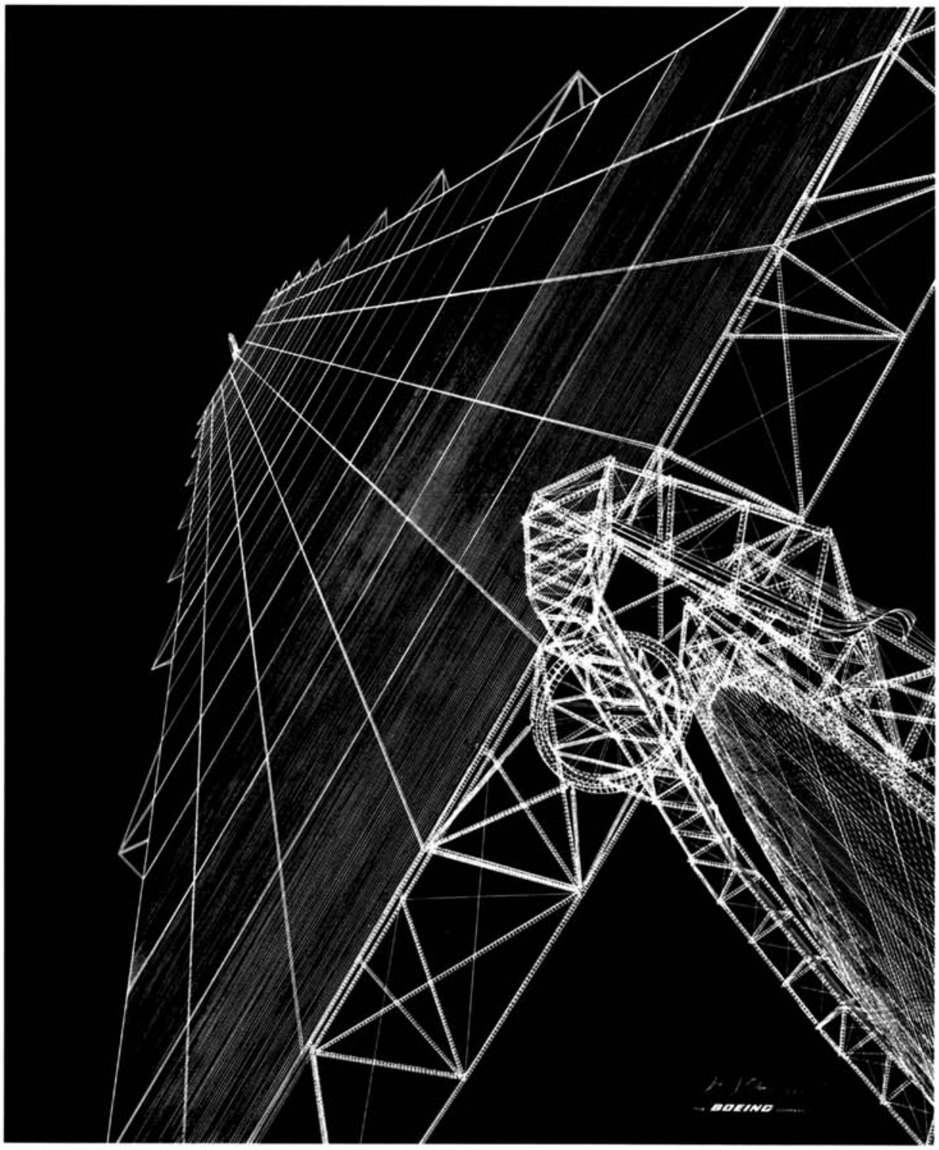
After check-out she will again be mated to her 747 and flown to Cape Canaveral. There will be five more orbital test flights before the Space Shuttle will be regarded as operational some time in 1980.



The 747 jet transport with its cargo, the Orbiter Columbia

High Frontier Politics

by Ken McCormick



In discussing legislative issues with members of the L-5 Society, I have become aware of certain widely-held ideas on the politics of space which seem to me to be rooted in misconception. I would like to challenge here a few of the more destructive of these ideas. One disclaimer I suppose I should make before proceeding is that although I have worked on some special projects for the L-5 Society, my own views expressed here are by no means a statement of L-5 Society policy.

What is undoubtedly the worst misconception that I have encountered (and encountered frequently) is that a Solar Power Satellite (SPS) construction program would not be important to the early achievement of a large-scale use of nonterrestrial resources and space settlement as described by Gerard K. O'Neill. This belief is often held by L-5er's who complain that SPS is a shaky and unpopular proposition and would well be ignored by high frontier enthusiasts. Since it is fairly well-agreed upon that no one is likely for purely spiritual reasons to provide the billions of dollars needed to build space colonies, anti-SPS space colony buffs tend to look to other areas of space industrialization to provide the economic incentive for investment in large space habitats. It is often stated that other space manufacturing ventures would be better stepping stones to O'Neill's goals than would SPS.

...no other project on the horizon even comes close to offering the spur to space colonization that SPS offers.

What is wrong with this belief is that no other project on the horizon even comes close to offering the spur to space colonization that SPS offers. Science Applications, Inc.'s study of space industrialization opportunities, published April 15, 1978, provides some indication of the relative importance of SPS to other now-anticipated space manufacturing projects. SAI estimated the cumulative revenues which might accrue by the year 2010 from the space manufacture of pharmaceuticals, semiconductors, fiber optics, special metals and other products, and came up with a total of 64 billion dollars. Using the same general assumptions, they also estimated the cumulative revenues from an SPS project over the same period at 200 to 600 billion dollars.

I believe it is evident that the investment of tens of billions of dollars in a large-scale nonterrestrial materials (NTM) utilization capability and in the construction of large space habitats would be more attractive as a part of a project capable of producing 600 billion dollars than as a part of a project capable of producing 64 billion dollars. I might add that Dr. O'Neill believes that SPS produced according to his own plan could ultimately provide all the world's new electrical generating capacity, and therefore would be producing revenues of at least $200 billion per year.

The simple comparison of revenues which can be expected to be produced by various projects is, I will admit, a very crude approach. There are many other things to be considered. The consideration of economic factors is something that many L-5'ers seem to have overlooked, however, and it is of primary importance. The human race will move civilization into space only as quickly as it can afford to do so. The need to explore and open new frontiers, alone, will not lead to the colonization of space any more quickly than it has led to the colonization of the Antarctic continent or to the construction of cities beneath the sea.

NASA has recently sought to determine what projects could be more economically accomplished using nonterrestrial resources than by launching the necessary materials from the Earth's surface. Only one project could be found which showed great promise. It was SPS. Restrictions were placed on the design of an NTM utilization project which many people feel are unduly stringent, but the fact that SPS *was* accepted as a possible incentive for an NTM investment is, I believe, significant.

Less conservative NTM utilization project design assumptions make NTM more attractive for use in space manufacturing endeavors other than SPS. Using only 13 Shuttle-loads of material, a scaled-down lunar mining facility could be established for as little as 6 to 10 billion dollars. This would be an absolutely minimal operation, and would deliver only a fraction of the raw material to orbit that the operation envisioned in SPS project designs would, but it would be designed for the capability of being expanded over time. This plan is often described as the "foot-in-the-door" scenario for NTM utilization.

The fact that the thrust of NTM utilization work has gone from the original "high frontier" scenario for lunar soil use in the construction of SPS to the "low profile road" to space manufacturing to the "foot-in-the-door" scenario does not necessarily imply that the foot-in-the-door approach would be the best stepping stone to space colonization. The foot-in-the-door scenario may very well be similar to the approach that is finally taken, but we should not now let a scaling-down of the requirements for NTM utilization lead us to a scaling down of our expectations.

The foot-in-the-door project would lead to at least a modest use of extraterrestrial materials. But NTM utilization is only half of the high frontier concept. The other half is probably more striking to most people; it is the prospect of thousands of ordinary men and women living and working in space within the next two or three decades. To arrive at *that*, it looks right now as though we will need SPS. NTM utilization only for products other than SPS would lead to a much more gradual build-up of the human presence in space. Unless some unexpected big project appeared on the horizon, what could be properly described as space colonies might not come into being for decades beyond the time frame for SPS.

I have sometimes heard the view expressed by L-5 Society members that there is a parting of the ways shaping up between one camp of SPS proponents, led by Peter Glaser, who support only the concept of ground-launched SPS, and another camp of proponents, led by Gerard O'Neill, who support only the concept of SPS produced from nonterrestrial materials. The belief is often held, moreover, that a ground-launched SPS program would be very destructive to any hope of achieving the goal of O'Neill's "high frontier," and that L-5'ers should therefore oppose the concept of ground-launched SPS.

This seems to me to be an example, on the amateur enthusiast level, of the "corrosive atmosphere of conflict" which was so well described in Eric Drexler's very excellent article on "The New Space Program" in the July 1978 **L-5 News.**

...Dr. O'Neill believes that SPS produced according to his own plan could ultimately provide all the world's new electrical generating capacity... producing revenues of at least $200 billion per year.

It is true that Dr. Glaser has not been as outspoken in his support of the nonterrestrial materials (NTM) option as some of us would like him to be. He has not yet incorporated the NTM option into his design or economic studies of SPS. He apparently feels, as do all of the SPS proponents within Congress and within NASA with whom I have spoken, that an SPS program can proceed more rapidly at this time with the NTM option on a back burner. Perhaps after ten long years of struggle to gain a measure of acceptance in NASA and in industry for the SPS concept, Dr. Glaser does not now relish the prospect of spearheading a similar drive to gain acceptance for lunar mining and space processing.

He does, however, support Dr. O'Neill's plan as one of the options to be considered for the construction of the satellites. A thoughtful reading of his reply to Rep. Albert Gore's inquiry about the NTM option for SPS last April may provide a degree of insight into his approach: "I am looking at a near-term development, and as such, I am looking at the things that I can describe in a reasonable certainty in reports based on analysis, design and experiment. I do not believe that (for) the kind of program that NASA and industry envisage for developing a solar power satellite, we need to *now* be concerned (with) whether or not to go to the Moon. *However*—once we have a commercial solar power satellite capability demonstrated, and it is seen as being of major global benefit, I believe at *that* point, examination and detailed studies and perhaps doing this lunar mining may be a *very* excellent way of reducing costs."

In the Senate last August, Dr. Glaser had this to say about the concept of the high frontier: "The SPS development program will focus development efforts on space processing, fabrication, assembly and maintenance, human habitations in orbit, space transportation efficiency, and the possible use of extraterrestrial resources, thus setting the stage for achievements which may transcend anything that heretofore has been achieved by the human species. I believe that we are here on the verge of a new evolution—an evolution that can take us into space in ways which we have dreamed about for many years."

Perhaps Dr. Glaser has been overly conservative in failing to incorporate the NTM option in his design studies; perhaps he has not. From what I have seen of the Washington power structure's attitude towards the idea of NTM utilization, I can certainly understand his reluctance to more strongly link it to his concept of SPS. I can also better appreciate the degree of support that he *has* given to Dr. O'Neill's ideas.

The theory that investment in a ground-launched SPS construction program would actually lead away from the "high frontier" is debatable at best. It can be argued that even that kind of SPS program would lead us, because of the great economic importance of SPS, to the use of nonterrestrial materials and to space settlement. This is clearly Peter Glaser's feeling on the matter. As he testified before Congress last August: "A prerequisite for deployment of the SPS is development of a truly economical capability for transportation to orbit and for large-scale construction in space; the possibility therefore arises of other forms of space industrialization and, eventually, of human settlement off Earth."

Both Dr. Glaser and Dr. O'Neill have indicated to me that they will continue to cooperate closely. Dr. Glaser, for example, will deliver a paper at the Princeton conference on space manufacturing, and will also be contributing a chapter to a book on space industrialization now being put together by O'Neill's close associate, Dr. Brian O'Leary. Dr. Glaser and Dr. O'Neill will also collaborate on a paper on SPS for the Vienna U.N. conference on science and technology for developing countries.

Some difference remains, of course. Dr. O'Neill would like to see more serious investigation at this time into the NTM option for SPS; Dr. Glaser feels that the question of *whether or not* to build SPS must be investigated further before an investigation of *how* to build SPS is undertaken. This difference certainly does not constitute a "parting of the ways," however. As time goes on, the two positions should draw closer together, not farther apart.

Some L-5'ers seem to feel that it is necessary to point out that Congress cannot realistically be expected to commit the nation to O'Neill's concept of NTM utilization for space industrialization. I believe that those people have managed to correctly assess the present situation, but I hope that pessimism will not silence their advocacy of the high frontier. The national mood is not totally immutable. With an SPS evaluation program favorably completed and a commercial SPS capability demonstrated, and thorough studies indicating that NTM and large space habitats could dramatically reduce the cost of SPS, Congress might very reasonably be expected to commit us to O'Neill's "high frontier." At this time, L-5'ers should certainly not be coy when it comes to advocating O'Neill's SPS plan as an option to be considered.

I have found many L-5 Society members who have an interest in political action to be distrustful of existing space legislation and to feel that the introduction of bills at the behest of L-5 pressure groups is the most effective course of action on the high frontier which is open to the citizen lobbyist. It seems to have become an article of popular wisdom that bills which do not mandate funds are nothing but an empty gesture.

The space policy bills of Senators Schmitt and Stevenson are good examples of bills which do not mandate funds, but which definitely are of value. As a matter of fact, it is a good rule of thumb for the citizen lobbyist to assume that any space bill which progresses through committee is designed by a member of Congress to be of some value.

Members of Congress must budget their energies carefully. It requires a certain amount of energy to really push a bill, and a very large expenditure of political energy to get a bill through committee. If someone is willing to expend the energy to do that, it is a pretty safe bet that he or she expects to accomplish something with that bill. Inevitably, some L-5'ers will question whether the member of Congress has the wisdom to know what will achieve something and what will not. Since most politicians have more political savvy than most L-5'ers, though, it behooves most L-5'ers to defer to the judgement of most politicians.

Citizens' groups will sometimes prevail upon congressmen to introduce legislation which deals with some issue that the group is interested in. However, the congressman will usually do so only as a gesture, and most bills of this type are buried in committee. The space movement is not large enough to demand action and get it. Fortunately, there are enough congressmen who see space as being in their own self-interest to make this kind of action unnecessary.

Letter writing, grassroots efforts in public education, and support of prospace politicians are not as dramatic as a visit to one's congressman to demand action, but they really do influence Congress. We can go a long way at this time by supporting and encouraging legislation which members of Congress truly want, and by working constantly to acclimate the establishment to the concept of the high frontier.

X-3 Shuttle Development

by Paul Geyer, TEI Astronaut Corps

Bob Truax's X-3 Space Shuttle developmental tests continue as Truax Engineering Inc. (TEI) has its first major financial backing. The first of three 24 foot, four engine vehicles is about 80% complete and the components for two others are on hand.

The X-3, a nongovernment sponsored vehicle, was conceived by Truax as a ballistic rocket, built from proven components from other space projects, which will take an astronaut on a 50-60 mile high flight in a suborbital trajectory with a range of 5-10 miles. Peak velocity will exceed 2,000 mph.

Bob Truax, a former space engineer, feels that the current NASA shuttle is using an "overkill" expensive technology and that ballistic vehicles are the most efficient for piloted flights. By cutting the reliability down from 99% to a few percent less, the cost factor becomes substantially reduced. In fact, some of the heavy lift launch vehicles for solar power satellites use large ballistic type boosters to transport material into initial low Earth orbit. A ballistic spacecraft is less complex and therefore less expensive and less hazardous than a "spaceplane" configuration.

The X-3 is powered by four Atlas/Thor verniers with a total thrust of 4,000 lbs. Considerable bench testing and developmental work is being done and at least one unpiloted test shot will be required before the vehicle is human-rated. Private financing of the project insures a true effort at flight by "Project Private Enterprise" which would result in the first nongovernment supported piloted space mission.

Total cost of the development through initial flight testing is estimated at over $800,000 which is a fraction of NASA costs even on an unpiloted mission. The supporters of the project will be honored by a "space honor roll," a scroll with contributors names to be ejected at the apex of the flight. Certificates will also be issued to supporters.

The project is far from a dangerous stunt. The X-3, when operational, could fly for $10,000 per mission. It could be a piloted vehicle for space research and even see use as an unpiloted reusable sounding rocket capable of lofting 400 pound payloads. Truax has a corps of 30 astronauts from which the pilot for the initial mission has yet to be selected. Obviously, the best qualified will fly and future opportunities await the others—flying for Truax or piloting the vehicle on a research mission

Speculation exists that the first shuttle mission for NASA may slip into 1980 due to engine problems and crew training problems (complex problems with the "space plane mission simulations"). It may be possible that an X-3 development flight may be launched before the orbiter.

According to Truax, scheduling depends on the level of funding but the program is proceeding well. Truax has commented, "The . . . program involves captive firings of the rocket, low altitude drop tests of recovery systems, high altitude drop tests, unmanned launchings, astronaut training, etc." Obviously safety will not be compromised for the sake of sensation-making headlines. The age of space flight by non-NASA astronauts may be much closer than we think.

NEWS BRIEFS

OTRAG, the private West German rocket firm, has been expelled from its Zaire launch facilities. The expulsion followed Soviet charges in an African radio broadcast that OTRAG had launched missiles with chemical warheads with the collusion of the U.S. Central Intelligence Agency and West Germany. The Soviets also accused OTRAG of signing an agreement with the South African Republic to provide them an air base. Hints were made that the Zaire missile test range would become the site of South African A-bomb tests.

Otrag's recent request for United Nations monitoring of its Zaire facilities came too little and too late.

The $25 million Solar Power Satellite Research and Development Act was voted out of the U.S. House of Representatives Science and Technology Committee May 15, just under the wire for the appropriations deadline. The voice vote was overwhelmingly favorable.

June 6 the U.S. Department of Energy (DOE) will conduct a briefing on solar power satellite alternatives. Jerry Grey of the AIAA will describe thermal cycle powersats. Ken Bellman will make a case for the "solaris"concept of simply reflecting the sunlight in space to Earthside solar power plants. Max Hunter will explain the potentials of laser power transmission, and Gerard O'Neill will describe how powersats could be constructed from extraterrestrial materials.

Later in this briefing the L-5 Society will present its members' comments. DOE expects to make major decisions on the thrust of its power satellite project. A favorable decision on any of the alternatives being presented at the briefing would translate into big government spending.

The North American Air Defense Command (NORAD) estimates that Skylab will crash sometime between June 20 and July 4. Most likely date is predicted to be June 26.

The 77.5 ton space station is expected to hit the ground in at least 500 pieces. The biggest are the 5,175 pound airlock shroud, a 3,901 pound lead film vault, six 2,736 pound oxygen tanks and a 1,578 pound bulkhead. The film vault is expected to have the highest impact velocity of 405 feet per second.

NASA's hopes of controlling Skylab's descent to end in an uninhabited area were dashed on April 23 when a control-moment gyro failed.

Those who worry about being caught by the hail of Skylab debris can call Johnson Space Center at 713/483-5111 for the latest NORAD predictions on the time and location of the impact. Predictions will be updated daily, then issued at 12, 6, 4, and 2 hour intervals as Skylab's firey demise approaches.

DOE Undersecretary Dale D. Meyers resigned June 1. His successor must be nominated by President Carter and confirmed by the U.S. Senate.

The Undersecretary of DOE has responsibility for development of new energy sources, including power satellites.

Marshall Space Center has begun a study of strap-on rocket motors to increase the space shuttle's thrust. This system would upgrade the shuttle's launch capability to 14,500 kg in a 277,800 km circumference circular polar orbit. The strap-on rockets are expected to be about 11 meters long,¼ the length of the shuttle's solid fuel boosters.

4th Biennial Princeton Conference

Sixty-eight papers were heard by one hundred and sixty-nine participants at the space manufacturing conference.

by Frederick H. Osborn, Jr.

The 4th Biennial Princeton Conference on space manufacturing held May 14th-17th, 1979 was sober and practical, as if the decision for adventure had been made and the time had come to assemble and test the gear for the trip.

This is powerful and heady stuff, as Roy Gibson, Director General of the European Space Agency remarked in his brilliant keynote address.

Director Gibson's concerns were reflected in 68 papers heard by 169 participants in the 12 sessions of the conference. The participants were a widely representative group, ranging in age from under a year to well over retirement age. There were 60 academicians, 35 businessmen and women, 27 representatives of foundations, institutions and societies, 13 government workers (including 7 from NASA), 9 foreign nationals, 7 writers, 4 lawyers, and 14 other interested citizens. While there were only 17 women, the quality of their contributions more than made up for their limited numbers.

Michael Michaud, currently on leave from the US Department of State, was the first of many speakers to profess that the views he expressed were his own, and not necessarily those of his employer. He noted that as Administration support for NASA's programs declines, armed services expenditures for rockets and satellites are rising to equal NASA's budget. He suggested, paradoxically, that we might begin looking to the Department of Defense for humanization of space!

Rashmi Mayur, just arrived from Bombay, India, emphasized humanity's needs in developing nations for the services space programs can provide in disaster warning, education, resource surveys, agriculture, communications, medicine, and new materials development. People in the developing nations, he said, are more alert to what space can provide than people in industrial nations.

Irwin Pikus and Edward Finch reported steady progress in the growing body of international space law, despite problems, cited by Pikus, as to whether the Moon treaty should apply to all celestial bodies, whether advance notice should be given of space missions, how to define the common heritage of humanity and the boundaries between air space and outer space, and how to control the use of geostationary orbit and the high frequency radio communications spectrum. Finch, a firm believer that outer space holds the key to world peace, urged flexibility and keeping options open.

There were 8 excellent papers on materials processing, particularly processing of lunar materials, 4 on mass drivers, 6 on new technical concepts, and 8 on fabrication and products. These showed a healthy trend toward maturity, from theory to experiment, bench hardware, and demonstration.

The cooperation between the natural scientists and the humanists who share an interest in these great endeavors, which has always been close, is getting still closer.

Further evidence of maturity was the inclusion of sessions on enviromental effects (5 papers), anthropology and psychology (3 papers) a mind-stretching session on asteroidal resources (6 papers), and, for the first time, present on the sidelines, an opportunity for speculative private investment. **Christian Basler's International Satellite Industries, Inc.**

The American Institute of Aeronautics and Astronautics will soon publish **Space Manufacturing** Volume No. 3, containing the papers presented at the conference, plus many of the questions and answers arising from their presentation. But that volume will only be able to express a part of the warm friendly feeling and the wealth of information exchanged at coffee breaks and after hours.

Freeman Dyson of the Institute for Advanced Study at Princeton had delivered a brilliant analysis of the Pilgrims' voyage across the Atlantic and the Mormon expedition across the Great Plains. He enumerated the tonnage of materials transported, the costs and the problems and compared them to O'Neill's High Frontier space migrations, to Island One and to the asteroids. Alas, by his analysis Island One seems to be beyond historical individual resources, but the asteroids seem to be well within. It was a rousing speech which stirred latent visions of the American Dream and brought a standing ovation.

Below the Woodrow Wilson Auditorium, where the technical sessions were held, giving on an underground lobby where coffee was served at morning and afternoon breaks, are half a dozen low-ceiling classrooms, closed in like catacombs. White walls on which slides and viewgraphs could be projected recall that cave described by Socrates on the 7th book of Plato's **Republic**. Half the conference participants gathered in one of these rooms Wednesday night, the third night of the conference, to hear Eric Drexler, an MIT graduate student, amplify his views on solar sails.

At this informal session, 11 month old Valerie Aurora Henson, refreshed from an afternoon nap, rejoiced as she crawled about under the tables which formed an open square in the center of the room. There were not enough chairs or space around the edge, so adults crawled under the tables too. (Christian Basler, distinguished president of International Satellite Industries, was the first to join her under the tables.) With each new arrival, Valerie Aurora cheered.

Gerry Driggers of Southern Research Institute introduced Eric, who stook against the wall where the slides illustrating his lecture were being projected.

Eric's idea was fascinating. A new Mayflower with ultra gossamer sails, moved by the gentle breath of the Sun's light to navigate the solar system. There was an awareness among the audience that space pioneers in the near future might be following the footsteps of the Pilgrims.

They are a hearty and very human lot, these space pioneers. They stayed the course through an excellent summary the following morning by doctors Grey, O'Leary, Vajk, Cheston and Kolm. Professor O'Neill, in his concluding remarks, observed that clean solar energy is available full time in space, that lunar soils, embodying materials for power satellite construction can be lifted from the Moon for 1/20th the energy needed to raise an equivalent mass from the Earth, that after 5 years of increasingly intensive review the science of the High Frontier seems to be sound, the engineering practical and within reach. The cooperation between the natural scientists and the humanists who share an interest in these great endeavors, which has always been close, is getting still closer. Metals and silicon are awaiting us high above the Earth. Now is the time to build a clean electric energy system. Space is where it's at!

Inside the L-5 Society

Errata

The following errors appeared in the May 1979 **L-5 News** in the article "Breakthrough" by Carolyn Henson:

Page 6, subhead "Solar Sail Uses"—the research and development price tag for solar sails could be as low as $100 *million*, not $100 *billion* as stated.

Page 7, in the quote from Eric Drexler—sail transportation costs from Apollo objects, at substantial traffic levels, should fall below *50¢*/kilogram not $50.

L-5 Montréal

L-5 Montreal is now a reality!
L-5 Montréal existe!
Officers for 1979 are:
Les membres de L'executif pour 1979 sont:
Président: François Coallier
Secrétaire: Daniel Fritzpatrik
Our business address is:
Notre addresse d'affaire est:
L-5 Montréal
A/S François Coallier
1816 Ducharme
Outremont, Québec
Canada H2V 1H4

Announcements:

Remember the Future

On July 20th, 1979 it will have been ten years since Neil Armstrong's famous words, "that's one small step for a man, one giant leap for mankind," echoed across the vastness of space to the waiting peoples of planet Earth. The Apollo program represented humankind's first small step into the ocean of space, but sadly, ten years later we still have not taken the much heralded "giant leap."

To keep you fully informed about space developments, the San Francisco/Bay Area Section of the American Astronautical Society invites you to a two day commemorative conference of the tenth anniversary of the Apollo 11 lunar landing with an emphasis on future programs. The conference will begin on Friday, July 20th, with a banquet featuring a retrospective look at Project Apollo. The following day, Saturday July 21, conference attendees will be given a chance to view both political and technical aspects of a giant leap into space.

Papers on a broad range of future space topics are invited, as well as organizational contributions from qualified individuals. The conference will be held at the San Francisco Airport Hilton.

For more information write—The San Francisco/Bay Area Section of the American Astronautical Society, P.O. Box 7205, Menlo Park, California 94025, or call Ed Stearns at (408) 742-2385.

First National L-5 Chapters Conference

Local chapters are the basis for grass-roots support within and without the L-5 Society. Often they are the only contact the general public has with the L-5 concepts. While space industrialization is presented on television and in magazines, it is through chapter events that the public can have all their questions answered on a personal basis. A father can discuss his concern that microwave radiation may be harmful to his children. A executive might learn how space manufacturing could offer new opportunities for his or her firm. The chapters are vehicles for making the fantastic idea of space colonization real to the lay public.

Each month sees the formation of new L-5 chapters, each with its own goals, each with its own strategies. As their numbers increase, the need for close communication and coordination grows. Activities are planned often in ignorance of what neighboring chapters are doing or what they could offer in the way of help or suggestions. Too often mistakes are repeated, opportunities missed.

In an effort to coordinate chapter activities and open lines of communication the Houston Chapter will host the First National L-5 Chapters Conference August 18 and 19. The theme of the Conference will be the running of an L-5 Chapter (its care and feeding). There will be lectures and workshops on just what goes into organizing an active chapter, how to work with the local media, what is involved in creating a successful newsletter and other topics of interest to L-5 activists. Chapter members from around the country are invited to make presentations so others may learn from their experiences.

The conference is also intended to be a social event. Close ties are often formed by simply sitting down and getting acquainted, exchanging ideas, discussing problems and generally finding out what the other guys are up to. Personal contacts may prove to be the best way to establish a sense of unity and interdependence among members from distant chapters.

Those chapter members or L-5 members not associated with a particular chapter, wishing to attend should write to:

Robert G. Nichols
L-5 Houston
907 Timber Cove Dr.
Seabrook, TX 77586

To a large degree the success of the Conference will depend on the participation by chapter members from around the country. Their experiences can contribute greatly to the success and development of other chapters. Those interested in taking part in organizing workshops or making presentations should submit a brief outline of their topic.

Those planning on attending should write at the earliest opportunity. Information will be mailed out concerning events and times, registration fees and accommodations. This conference can only be a success with the cooperation and representation of all the chapters. L-5 is your Society. It can only grow and prosper with your support.

Ontario Wake Up!

There are quite a number of L-5 members in Ontario, more than Quebec, Nova Scotia and British Columbia put together, but there isn't any chapter there! Where are the dedicated L-5 members ready to invest their time in starting to organize local activities?

Members of L-5 Montreal share the desire for the Canadian local chapters to organize a **Canada L-5** and send a representative to the board of directors of the L-5 Society. With the sanction of L-5 headquarters, this would form a coalition of Canadian members to represent their interests at board policy meetings. The L-5 Society is an organization with an international potential. We in Canada, along with members in other countries, should help transform the potential into a full reality. So . . .

François Coallier
President, L-5 Montreal

Letters

In regards to the Oberg review (**L-5 News**, April 1979), I have only one brief comment which goes to the heart of the issue. I fail to perceive the distinction being made between "illusory" gaps and "lying" about bomber missiles, or ASAT gaps. The point of revealing the "gaps" between alleged Soviet superiority and actual Russian capabilities is not *necessarily* to accuse U.S. officialdom of being dishonest (though the Pentagon Papers, CIA domestic operations and Watergate affairs prove this is hardly impossible), but rather to show that the Pentagon alarmists have repeatedly been *wrong*. The various "gaps," of which the "throw-weight" gap is the latest, have certainly been "fictitious" in that they have been untrue. Even to be charitable, one must realize that these "gaps" have not been based merely on what is *known* about Soviet capabilities, as Oberg asserts, but rather on what is extrapolated in worst-case scenarios from estimated Soviet capabilities. While some might argue that the DOD might not be crying "wolf" this time in regards to ASATs, the historical record warns us to be more cautious before we throw more money and energy into elaborate new weapons systems and new—and as yet unproved—areas of conflict. I think we would all agree that national boundaries don't exist in outer space.

On one small point, I would caution the author on dwelling on particle beam weapons. As the published work of an MIT group of physicists, including SANE Board member Kosta Tsipis, and of IBM's Richard Garwin suggests, PBW's are infeasible and not worth attention.

Jeff Philips
SANE
Washington, D.C.

Dear Mr. Philips,

The brief comment of yours which you claim "goes to the heart of the issue" does not do so. It does demonstrate a set of assumptions which portray a gap far wider than the weapons gaps referred to. For example, your statement that "Pentagon alarmists have repeatedly been wrong" is in marked contrast to a documented claim by Francis P. Hoeber (president of a defense and economics study in Arlington, Virginia, author of "Six Myths About the Defense Budget," **Air University Review** *Sep-Oct 1978) that "Far from exaggerating the size of the Soviet threat, throughout the 1960s and the early 1970s, the official predictions of the Soviet strategic forces were below the numbers that turned out to be actually deployed." And surely you do not assert that Great Britain in the 1930s should not have built up the RAF until the Germans had actually begun to bomb London, do you? That is not a stretched analogy—not nearly as off target as your motherhood cliche that "I think we would all agree that national boundaries don't exist in outer space," a fact which has nothing at all to do with* any *of the points in dispute, since national sovereignty and responsibility does indeed extend into outer space as recognized by several United Nations treaties.*

The Tsipis study in Scientific American is interesting but, I'm afraid, flawed nearly as badly as the STAR WARS REVISTED pamphlet (and by the way I do note that you do not *dispute my criticisms of the pamphlet's lousy logic and phony facts—just as I did not dispute your conclusions that it would be a good idea to refrain from outer space arms races).*

I am still serious about discussing the issues of war in space, leaving aside your platitudes and generalizations. Can we begin?

James E. Oberg
Dickinson, TX

As a regular reader of L-5 News I have found only one blemish in an otherwise excellent magazine; namely, a continuing naiveté about the military mission in space. James Oberg's critique of "Star Wars Revisited" (**L-5 News**, April '79) was a welcome exception. The military advantages of space are many and varied, and to believe these advantages will be ignored or that they are insignificant is truly INSANE (absolutely no pun intended!). There will always be a place for antiwar idealists both on Earth and in space, but it will be the realists that pragmatically cooperate with the military who initially settle space. Indeed, without DOD concurrence and active support NASA's space shuttle would still be in committee. Similarly, the SPS concept will never be seriously pursued without the blessing of the military (How do you defend such a structure? It is more complicated than lasers and particle beams!)

The military currently spends a great deal on space programs, and much of the technology gained will be used by NASA and space settlers alike to conquer the heavens. I sincerely hope that L-5 members everywhere will come to look on the military as a friend and ally worthy of your cooperation. After all, the goals of the military and L-5 aren't so very different: L-5, to seek out and build new worlds; the military, to keep peace on the old.

J.M. Sponable
Lompoc, CA

I have an idea that might improve L-5 as well as save time and money. After the pressure hull is completed and spin has been started, subway lines, electrical conduits, and sewage lines should be laid on the inner surface of the pressure hull (i.e. floor) and fastened in place. No attempt should be made to do more than secure them in position, *laying on top of* the pressure hull. This is known in radio as a "breadboard" layout. Then the entire inner surface is covered with waste slag crushed to cobblestone size to such a depth that all installations are completely buried. Enough slag should be used so that it covers all installations to a depth of several feet. A layer of baseball sized slag should then be laid on top of the base slag, followed by one of pea-sized gravel, and topped by a layer of fine crushed sand.

On top of this surface houses are built, roadways laid, and it becomes, when fertilized, a well drained artificial soil good for growing vegetables, baseball fields, and (best of all) flowers. Houses could easily be constructed on this medium and attached to the underground utility lines. If we wished to alter the surface layout, removal and reconstruction would be relatively easy.

Also, the many feet of slag would be as good a radiation shield as a ring of cast slag on the outside of the pressure hull. Metal casting in space will be difficult enough without the added problem of casting slag plates. The irregular pieces left from the metal casting could easily be crushed by running through a small mill. Of course, *any* rock, refined or not, could be used with good results.

Finally, it becomes a matter of aesthetics. Would we rather spend our lives on a metal deck with boxes for flowers, or be able to see a wild flower grow, not because it was planted, but because a seed fell on the soil and found it good?

Ed Altenritter
Flint, MI

I've been reading some pretty disturbing stuff in **Aviation Week & Space Technology** recently. The recently-disclosed arms race between us and the Russians to develop super laser and/or particle beam weapons to zap satalites and ICBMs could lead to bigger and better balance of terror. Laser-armed orbital "Battle stations" (Honest! That's what the Army calls 'em, just like the Death Star in *Star Wars* . . .), killer satellites, and the proposed USAF "Space Command" all raise the specter of war in space.

The recent invasion of Shaba Province in Zaire has been interpreted by some experts as a space war of sorts here on Earth; the best way to deny access to space is to prevent the enemy from getting off the ground in the first place, which is just what the USSR, working thru friends in Africa, was trying to do to OTRAG (There were other "legitimate" reasons for the Zaire affaire, from the Soviet point of view, but the elimination of free-enterprise capitalism in space would have been a very useful long-range by-product). Meanwhile the Soviet space program is in high gear with manned space stations, a potential space tug, a small space shuttle in development, and some academicians talking enthusiastically about piloted missions to Mars and beyond in the next decade . . . I guess they don't have any Proxmires in the Kremlin.

And now NASA has abandoned all hope for Skylab; they're just going to let it fall to earth, some time during the summer of '79. According to an earlier NASA evaluation, even if we asked the Russians to help save Skylab, which seems doubtful, they wouldn't be able to.

And on top of that comes word that the NASA budget for Fiscal Year 1980 will be so tight that NASA will not be able to start any new flight programs and may even have to drop the Halley's Comet probe. The 25-kw power module, which would provide energy for materials processing and other good things in orbit (not to mention paving the way for solar power satellite technology), has been moved back to FY'81 where it will compete for funds with planned thrust augmentation for the Space Shuttle. Thrust augmentation is required to launch and recover 32,000-lb. USAF recon satellites (and in light of increased military interest in space, can you guess which program will have the higher priority?). And the first launch of the Shuttle keeps getting moved back farther.

On the brighter side, Senators Schmitt and Stevenson are supposed to be introducing some very interesting bills which could change things considerably, and even NASA is becoming marginally aware of the generally favorable public opinion in this country toward Space. Committee Hearings will be starting up in the near future . . .

I hesitate to suggest the obvious, but I will: the time has come once again for a serious, large-scale letter-writing/political action/lobbying campaign to save the Space Program from being slowly strangled to death by the Potomac paper-pushers. Those short-sighted so-called public servants of ours are messing around with *our future!* We have to stress to the Congress and the Administration (which includes NASA and OMB) that more money for NASA is beneficial. The Space Program (and more specifically Space Industrialization) is not just another rat hole down which the bureaucrats pour our tax dollars; it is a high-yield *investment* which has and will continue to pay huge dividends. The OMB is nickel-and-diming our dreams to death. We have to make them realize that the kinds of projects the L-5 Society supports are different from a new weapon system, for example, or a change in the Social Security tax structure. Full utilization of the High Frontier can help to solve basic economic problems here on Earth so that we may be able to eliminate the *need* for new weapon systems and also be able to afford *any* social program we want.

In conjunction with efforts to achieve official State recognition of July 20, 1979, as "Space Day", we should mount an all-out effort to obtain *more* funding for NASA. We should also do whatever is possible to get space development out of the hands of the politicians and out into the Market where it belongs. Otherwise, we'll continue to see smaller and smaller budgets each year, and the only activities in Space will be those of the Soviet Union and our own Pentagon . . .

If any L-5ers are interested in helping to mount such a campaign (or if you are already doing so and would like my help and money), please contact me as soon as possible. Maybe the latest oil price increase and a long, cold winter will help stir renewed enthusiasm for solar power satellites? One can only hope.

Waiting for feedback,

Robert G. Lovell
1754 Park Ave.
Baltimore, Maryland 21217

Rejoice members—we are finally being taken seriously!!! On April 5th during an ABC news special entitled "Energy: Crisis and Questions" the use of solar satellite power stations as an alternative energy source for this country was referenced. This reference is monumentous in that the highest rated network in this country nationally proclaimed that SPS's are a probable future energy source "that could be developed in only 10-20 years." Even more important is that for many Americans it was the first time they had even heard of this type of *practical* use of space by NASA.

Let's all help keep up our public exposure, for it can be one of our greatest assets in gaining support to further fund our space program.

Steven J. Hoeser
Eau Claire, WI

Harrisburg seems a plus for space energy. I am truly surprised to discover that Ms. Huddle and the 60's and 70's style activists turned out to be right about something. Still, in the intermediate term, the Harrisburg incident will put an energy/budget crimp on hardware like the Shuttle. In the long run . . .

David Murphy
Carterville, Illinois

L5 NEWS

August 1979

"Pilgrims, Saints and Spacemen"—
Special Preview of Freeman Dyson's Forthcoming Book
Asteroid Features: Peanut-Shaped, Mined, and Falling

L-5 NEWS

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In this issue:

1 **Pilgrims, Saints and Spacemen.** *Will the settlement of space be the most expensive and courageous undertaking in the history of humanity? Or have we taken steps this large before? The* **L-5 News** *presents a preview of Freeman J. Dyson's yet to be released book,* **Disturbing the Universe.**

5 **The Environmental "Impact" of Not Mining the Asteroids.** *If your fear of objects falling from the sky have been calmed by the re-entry of Skylab, then crawl back under the bed and read this article by Gregory L. Matloff.*

6 **L-5 Hosts Giant Peanut** *by Carolyn Henson. "Jimmy" in outer space?*

7 **The Asteroids: Supply Stations for Elements** *by Michael A. Pelizzari. We can "prospect the skies" and find all our needs in abundance.*

8 **Gas Entrained Solids—A Heat Transfer Fluid For Use in Space** *Part II of H. Keith Henson's and K. Eric Drexler's paper from the 1979 Princeton Manufacturing Conference.*

10 **News Briefs**

11 **Book Reviews** *J. Peter Vajk's* **Doomsday Has Been Cancelled** *is reviewed by Chris Peterson, and Ed Bas comments on Arthur C. Clarke's* **The Fountains of Paradise.**

12 **O'Neill Shows the Way** *by Ken McCormick. When a Congressional workshop needed a speaker on non-terrestrial material, they sent for Gerard O'Neill*

13 **Reading News**

14 **Announcements**

16 **Inside the L-5 Society**

17 **Letters**

Cover: This unusual asteroid was recently discovered in the Jupiter/Sun L-5 libration point. See "L-5 Hosts Giant Peanut" on page 6 of this issue. (Painting by William K. Hartmann.)

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An exciting preview of Freeman J. Dyson's forthcoming book **Disturbing the Universe.** *(Copyright ©1979 by Freeman J. Dyson; Harper & Row, Publishers, Inc.)*

Pilgrims, Saints and Spacemen

Artwork by James Babcock

by Freeman J. Dyson

Governor William Bradford of the Plymouth Colony, President Brigham Young of the church of Jesus Christ of Latter-day Saints, and my friend Professor Gerard O'Neill of the Princeton University physics department have much in common. Each of the three is a man of vision. Each believes passionately in the ability of ordinary men and women to go out into the wilderness and build there a society better than the one they left behind. Each has written a book to record for posterity his vision and his struggles. Each has his feet firmly on the ground in the real world of politics and finance. Each is acutely aware of the importance of dollars and cents, or pounds and shillings, in making his dreams come true.

The histories of Bradford and Young were not printed during their lifetimes but were left in manuscript form for the guidance of their followers. Bradford's manuscript was published two centuries later under the title **History of Plymouth Plantation**. Young's manuscript is quoted extensively, but not in full, in the official history of the Mormon church. O'Neill's book, **The High Frontier**, fortunately did not have to wait for posthumous publication.

The human and economic problems that the space colonists of tomorrow will face are not essentially different from the problems faced by Bradford in 1620 and by Young in 1847. Unfortunately, the extravagant style and exorbitant costs of the Apollo expeditions to the Moon have created in the minds of the public the impression that any human activities in space must necessarily cost tens of billions of dollars. I believe this impression to be fundamentally mistaken. If we reject the style of Apollo and follow the style of the *Mayflower* and the Mormons, we shall find the costs of space colonization coming down to a reasonable level. By a reasonable level of costs I mean a sum of money comparable to the sums which the Pilgrims and the Mormons successfully raised.

The human and economic problems that the space colonists of tomorrow will face are not essentially different from the problems faced by Bradford in 1620 and by Young in 1847.

Bradford and Young provide abundant documentation of the difficulties they faced in raising funds. Bradford emphasizes in his book that the toughest problem in the whole venture of colonization was to define a set of objectives upon which the brethren could agree:

> But as in all businesses the acting part is most difficult, especially where the work of many agents must concur, so was it found in this. For some of those that should have gone in England fell off and would not go; other merchants and friends that had offered to adventure their moneys withdrew and pretended many excuses; some disliking they went not to Guiana; others again would adventure nothing except they went to Virginia. Some again (and those that were most relied on) fell in utter dislike of Virginia and would do nothing if they went thither.

Without agreement upon objectives, the task of fund raising becomes impossible. This is a fact of life which remains as true today as it was in 1620. Bradford and Young devote more pages of their histories to the preliminary battles over objectives and finance than they devote to the description of their voyages. For both of them, it came as a blessed relief when the miseries of indecision were over, the expeditions were ready to go, and they were finally able to turn their attention away from political and financial matters to the simpler problems of physical survival. Here is Young writing from his winter quarters in February 1847, six weeks before starting his journey across the plains:

> I feel like a father with a great family of children around me, in a winter storm, and I am looking with calmness, confidence and patience, for the clouds to break and the Sun to shine, so that I can run out and plant and sow and gather in the corn and wheat and say, children, come home, winter is approaching again and I have homes and wood and flour and meal and meat and potatoes and squashes and onions and cabbages and all things in abundance, and I am ready to kill the fatted calf and make a joyful feast to all who will come and partake. We have done all we could here and are satisfied it will be all right in the end.

But I must come back from these idyllic sentiments to questions of dollars and cents. Two years earlier, Young reported:

Artwork by Robert Cannon

> For an outfit that every family of five persons would require: one good wagon, three yoke of cattle, two cows, two beef cattle, three sheep, one thousand pounds of flour, twenty pounds of sugar, one rifle and ammunition, a tent and tent-poles—the cost would be about $250 provided the family had nothing to begin with, only bedding and cooking utensils, and the weight would be about twenty-seven hundred [pounds] including the family.

...it came as a blessed relief when the miseries of indecision were over, the expeditions were ready to go, and they were finally able to turn their attention from political and financial matters to the simpler problems of physical survival.

The arts were also included in Young's budget. On November 1, 1845, he paid $150 to purchase instruments for the brass band. This was a wise investment, for the band

> Was sometimes invited to give concerts at villages near to the line of march, which did much to change the feelings of hostility which occasionally was manifested in such places. Thus the band proved a very great benefit to the marching column, besides cheering the spirit of the pilgrims.

The actual numbers that crossed the plains with Young were: 1,891 souls, 623 wagons, 131 horses, 44 mules, 2,012 oxen, 983 cows, 334 loose cattle, 654 sheep, 237 pigs, 904 chickens.

So we can estimate the total payload of Young's expedition to be 3,500 tons, mainly consisting of animals on the hoof, and the total cost to be $150,000 in 1847 dollars.

Bradford unfortunately does not provide such an exact accounting for the *Mayflower*. He quotes a letter from Robert Cushman, dated June 10, 1620, in London, two months before the sailing. Cushman was one of the people in charge of provisioning for the voyage:

> Loving Friend, I have received from you some letters, full of affection and complaints, and what it is you would have of me I know not; for your crying out, "Negligence, negligence, negligence," I marvel why so negligent a man was used in the business.—Counting upon 150 persons, there cannot be found above £1200 and odd moneys of all the ventures you can reckon, besides some cloth, stockings and shoes which are not counted, so we shall come short at least £300 or £400. I would have had something shortened at first of beer and other provisions, in hope of other adventures; and now we could, both in Amsterdam and Kent, have beer enough to serve our turn, but now we cannot accept it without prejudice—£500 you say will serve; for the rest which here and in Holland is to be used, we may go scratch for it.—Think the best of all and bear with patience what is wanting, and the Lord guide us all.
>
> Your loving friend, Robert Cushman

This letter shows that Cushman was personally responsible for meeting expenses to the tune of £1500. It does not say whether all the expenses, and in particular the rental fee for the *Mayflower*, were included in this figure.

Three weeks later, on July 1, 1620, an agreement was signed between the Planters and the Adventurers. The Planters were the colonists. The Adventurers were the shareholders who invested money in the enterprise and stayed at home. The agreement stipulated "that at the end of the seven years, the capital and profits, viz. the houses, lands, goods and chattels, be divided equally betwixt the Adventurers and Planters." Another clause of the agreement gave one share to each of the Planters as a bonus for their seven years of hard labor: "Every person that goeth being aged 16 years and upward be rated at £10, and £10 to be accounted a single share." Any cash that the Planters contributed would entitle them to additional shares.

The 1620 agreement proved unsatisfactory to both sides and caused constant friction. In 1626, a year before the planned division of assets, the whole matter was renegotiated and a new agreement was signed, "drawn by the best counsel of law they could get, to make it firm." The 1626 agreement stipulated that the Adventurers sell to the Planters, "in consideration of the sum of one thousand and eight hundred pounds sterling to be paid in manner and form following,—all and every the stocks, shares, lands, merchandise and chattels—any way accruing or belonging to the generality of the said Adventurers aforesaid." Having bought out the Adventurers' shares, the Planters were left with a debt of £1800, which they finally succeeded in paying off twenty-two years later.

I do not know how much profit or loss the Adventurers took in the 1626 settlement. I also do not know how large a fraction of the original cost of the expedition was paid by the Planters. As to the first point, it is unlikely that the Adventurers took a loss, for the colony was not bankrupt in 1626 and the Adventurers were not in the habit of lending their money for nothing. As to the second point, it is unlikely that the Planters paid as much as half of the original costs. If they had been in a position to pay half, they would probably have managed to squeeze the expenses down to such a point that they could do without the Adventurers altogether and avoid the innumerable headaches that the partnership brought with it. I therefore conclude from the evidence of the 1626 settlement that £3600 is a safe upper limit to the original cost of renting and provisioning the *Mayflower*. The evidence of the Cushman letter implies a lower limit of £1500. I shall adopt £2500 as my estimate of the cost of the expedition in 1620 pounds. This figure can hardly be wrong by a factor of two either way. The payload of the *Mayflower* is stated explicitly by Bradford. It was 180 tons.

> *...both the Mayflower and the Mormon expeditions were extremely expensive operations. In their time, each of them stretched the limits of what a group of private people without government support could accomplish.*

My next problem is to convert the 1620 and 1847 cost figures into their modern equivalents. A good source of information about the history of wages and prices in England is the work of Ernest Phelps Brown and Sheila Hopkins, published in two articles in the journal **Economica** and reprinted in a series called **Essays in Economic History**, put out by the Economic History Society. The first article deals with wages, the second with prices. It is a question of taste whether one prefers to use wages or prices as the basis for comparing costs between different centuries. If we use wages, we are saying that an hour of a workingman's time in 1620 is equivalent to an hour in 1979. If we use prices, we are saying that a pound of butter in 1620 is equivalent to a pound of butter today. My personal opinion is that wages give a truer standard of comparison than prices. My purpose in making the comparison is to try to define in a roughly quantitative fashion the size of the human efforts that the *Mayflower* and the Mormon expeditions demanded.

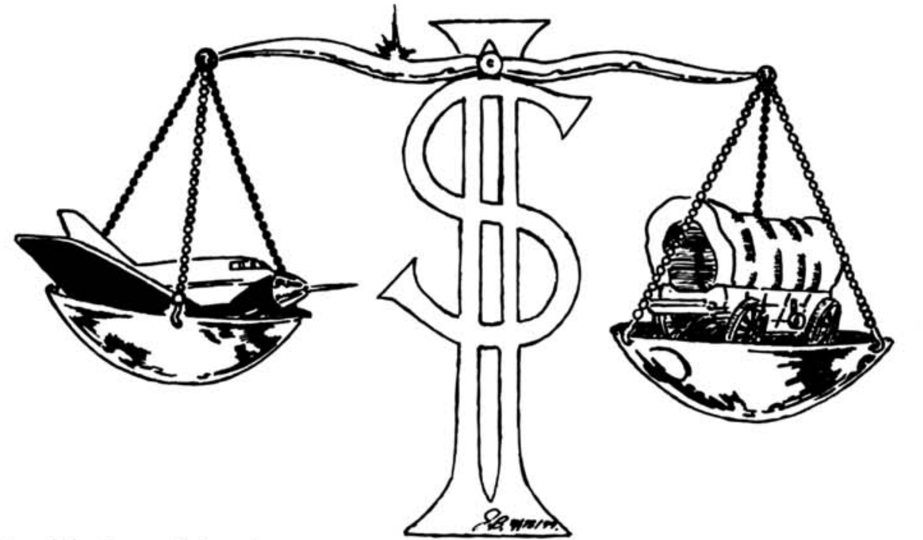
According to Phelps Brown and Hopkins, the wages of workers in the building trade in 1620 were in the range from 8 to 12 pence per day. In 1847 the range was from 33 to 49 pence. For the modern equivalent of these numbers I take the minimum rate of $9.63 per hour imposed by building trade union contracts in New York in 1975. The exchange rates on the basis of wages are then:

£1 (1620) equals $2500 (1975)
$1 (1847) equals $100 (1975)

These are very approximate numbers. A rough check on the numbers for 1620 is provided by the fact, already mentioned, that each Planter received a credit of £10 for going to Plymouth and working for the community for seven years without wages.

The estimated total costs in 1975 dollars are then 6 million for the *Mayflower* and 15 million for the Mormons. On this basis I have drawn up the first two columns of Table 1. The point I am trying to emphasize with these numbers is that both the *Mayflower* and Mormon expeditions were extremely expensive operations. In their time, each of them stretched the limits of what a group of private people without governmental support could accomplish.

The numbers in the bottom row of Table I give an estimate of the number of years an average wage earner would have had to save his entire income to pay the passage for his family. Although the average Mormon family was twice as large as the average *Mayflower* family, the cost in man-years per family was three times as large for the *Mayflower* as it was for the Mormons. This difference had a decisive effect on the financing of the colonies. An average person, with single-minded dedication to a cause and with a little help from his friends, can save two or three times his annual income. An average person with a family to feed, no matter how dedicated he may be, cannot save seven times his income. So the Mormons were able to pay their way, while the Planters on the *Mayflower* were forced to borrow heavily from the Adventurers and to run up debts which took twenty-two years to pay off. Somewhere between two and seven man-years per family comes the breaking point, beyond which simple do-it-yourself financing by ordinary people becomes impossible.



Artwork by James Babcock

TABLE 1: Comparison of Four Expeditions
(Cost exchange rates based on building trade wages)
(M means milions)

Expedition	May-flower	Mor-mons	Island One L5 Colony	Home-steading the Asteroids
Date	1620	1847	1990+	2000+
Number of People	103	1891	10000	23
Payload (tons)	180	3500	3.6M	50
Payload (tons) per person	1.8	2	360	2
Cost (1975 dollars	$6M	$15M	$96000M	$1M
Cost per pound (1975 dol.)	$15	$2	$13	$10
Cost in man-years per family	7.5	2.5	1500	6

I said nothing yet about the last two columns in my table. These represent two contrasting styles of space colonization, both taken from O'Neill's book, with some changes for which I am responsible. Column 3 comes from O'Neill's Chapter 8, which he entitles "The First New World," describing space colonization organized by the American government in the official NASA style. Column 4 comes from O'Neill's Chapter 11, with the title "Homesteading the Asteroids," in which he describes space colonization done in the *Mayflower* style by a bunch of enthusiastic amateurs.

The cost of the "Island One" project is $96 billion. Many people, myself included, feel that $96 billion is a preposterously large amount of money to spend on any single enterprise. But still we have to take this number seriously. It was arrived at by a group of competent engineers and accountants familiar with the ways of the government and the aerospace industry. It is probably the most accurate of all the cost estimates that I have included in Table I. For this $96 billion you can buy a great deal of hardware. You can buy a complete floating city to house and support ten thousand people with all modern conveniences at the magic point L5, which is just as far from the Earth and from the Moon as these bodies are from each other. You can buy enough synthetic farmland to make a closed ecological system which supplies the colonists with food and water and air. You can buy a spaceborne factory in which the colonists manufacture solar power stations to transmit huge amounts of energy in the form of microwave beams to receivers on the Earth. All these things may one day come to pass. It may well be true, as O'Neill claims, that the investment of $96 billion will be repaid in twenty-four years out of the profits accruing from the sale of electricity. If the debt could be paid off in twenty-four years, that would be almost as quick as the *Mayflower* Planters could do it. But there is one inescapable difference between Island One and the *Mayflower*. The bottom row of Table I shows that the Island One colonist would have to work for 1500 years to pay his family's share of the costs. This means that Island One cannot by any stretch of the imagination be considered as a private adventure. It must inevitably be a government project, with bureaucratic management, with national prestige at stake, and with occupational health and safety regulations rigidly enforced. As soon as our government takes responsiblity for such a project, any serious risk of failure or of loss of life becomes politically unacceptable. The costs of Island One become high for the same reason that the costs of the Apollo expeditions were high. The government can afford to waste money but it cannot afford to be responsible for a disaster.

Can a family, bringing a total weight of only two tons per person, arrive at an asteroid, build themselves a home and a greenhouse, plant seeds and raise crops in the soil as they find it and survive?

After this brief visit to the superhygienic welfare state at Island One, let us go on to the last column of Table I. The last column describes O'Neill's vision of a group of young pioneers who save enough money to move out on their own from the L5 colony into the wilderness of the asteroid belt. They are going on a one-way trip at their own risk. The cost estimates here describe hopes rather than facts. Nobody can possibly know today whether it will be feasible for a group of twenty-three private people to equip such an expedition at a total cost of a million dollars. Anybody who is professionally qualified to estimate costs will say that this figure is absurdly low. I do not believe that it is absurdly low. It is no accident that the per capita cost estimates for the asteroid colony turn out to be similar to those of the *Mayflower*. This is the maximum level of costs at which the space beyond the Earth will give back to us the open frontier that we no longer possess on this planet.

According to the third and fourth columns of Table I, the cost per pound of the asteroid expedition is not significantly less than that of Island One. The big differences between the two expeditions lie in the number of people and in the weight carried per person. The feasibility of cheap space colonization in the style of the asteroid expedition depends upon one crucial question. Can a family, bringing a total weight of only two tons per person, arrive at an asteroid, build themselves a home and a greenhouse, plant seeds and raise crops in the soil as they find it, and survive? This is what the *Mayflower* and Mormon colonists did, and it is what the space colonists must do if they are to be truly free and independent.

No space probe has yet visited an asteroid. No scientific instruments have even been flown by an asteroid to give us a closer look at it. We are still as ignorant of the topography and chemistry of the asteroids as we were ignorant of the topography of Mars before the Mariner and Viking missions. Until some of the asteroids have been surveyed with instruments, it is pointless to try to foresee in detail the problems that colonists would face in making themselves at home there. Cost estimates for farming on an asteroid are meaningless until we know whether the soil is soft enough to be dug without using dynamite. Instead of speculating about the mechanics of space colonization in an unknown environment, I will only mention some institutional reasons why it may not be absurd to imagine a reduction in costs by a factor of 100,000 from the $96 billion of Island One to the $1 million of the asteroid colony. First we save a factor of four hundred by reducing the number of people from ten thousand to twenty-three. That leaves a factor of 250 still to be found. We may hope to save a factor of ten by accepting risks and hardships that no government would impose upon its employees, and another factor of five by eliminating trade union rules and bureaucratic management. The last factor of five will be harder to find. It might come from new technology, or more probably from salvaging and reusing equipment left over from earlier government projects. There are already today several hundred derelict spacecraft in orbit around the Earth, besides a number on the Moon, waiting for our asteroid pioneers to collect and refurbish them.

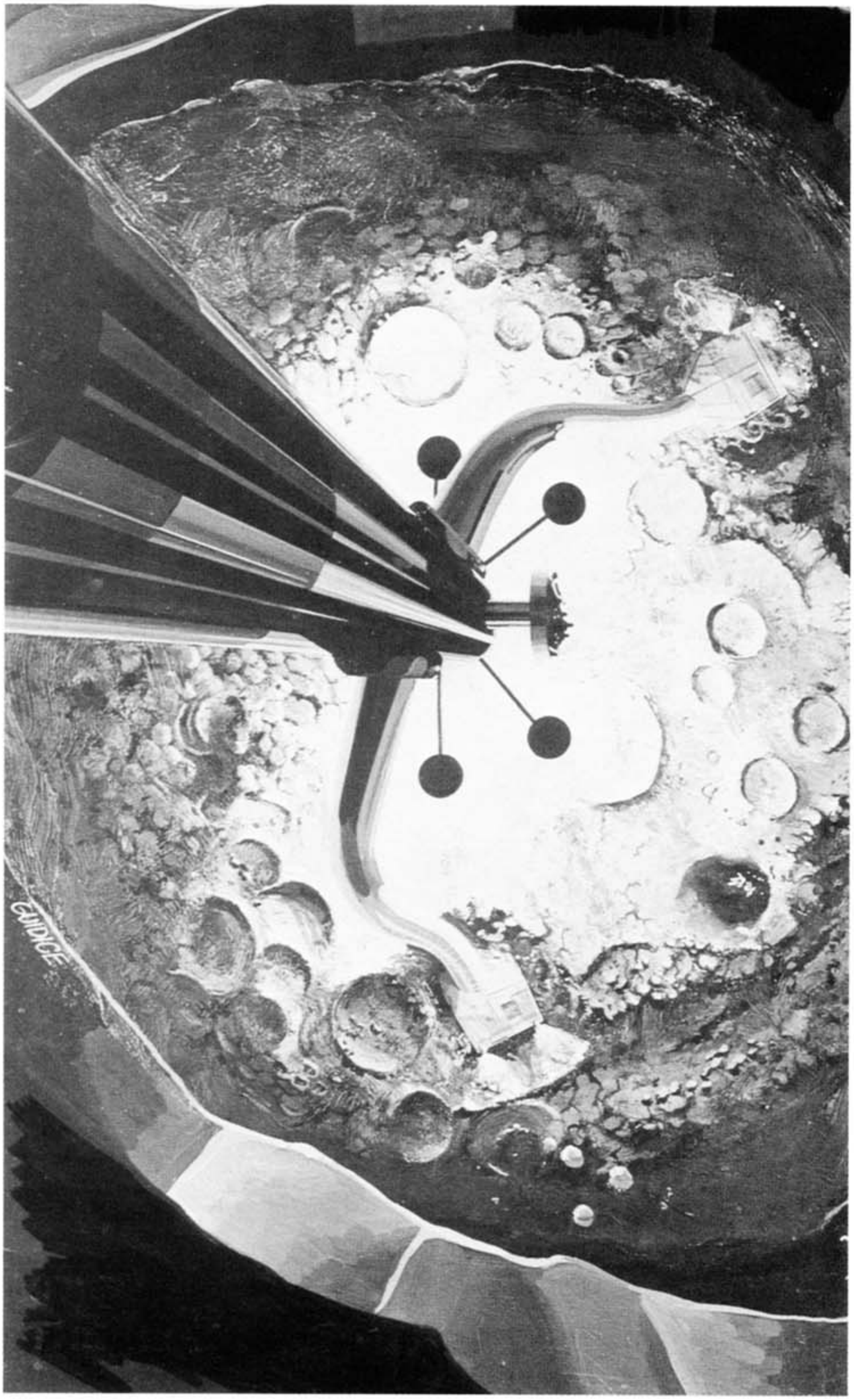
Artwork by James Babcock

The Island One and the asteroid homesteading expeditions are extreme cases. I chose them to illustrate high and low estimates of the costs of colonization. The true costs, when colonization begins, will probably lie somewhere in between. In so difficult and long-range a venture, there is room for a mixture of styles. Governmental, industrial and private operations must all go forward, learning and borrowing from one another, before we shall find out how to establish colonies safely and cheaply. The private adventurers will need all the help they can get from governmental and commercial experience. In this connection, it is worth remembering that 128 years passed between the voyages of Columbus and the *Mayflower*. In those 128 years, the kings and queens and princes of Spain and Portugal, England and Holland, were building the shops and establishing the commercial infrastructure that would make the *Mayflower* possible.

O'Neill and I have a dream, that one day there will be a free expansion of small groups of private citizens all over the solar system and beyond. Perhaps it is an idle dream. It is a question of dollars and cents, as Bradford and Young well knew. We shall never find out what is possible until we try it.

The Environmental "Impact" of Not Mining the Asteroids

by Gregory L. Matloff



Utilization of material from Earth-approaching (Apollo and Amor) asteroids has been considered in plans for large space construction projects such as space habitats or solar power satellites.(1,2) Earth approach asteroids are short-lived, impacting Venus, Earth, or Moon in 10^7—10^8 years. Current estimates of total Amor and Apollo population are 1600±800 for a diameter greater than 1 km, and about 10^5 asteroids are larger than 100 m.(1,3)

In addition, there must be many smaller bodies belonging to the Earth-approach families. On Aug. 10, 1972, an approximately 1,000 ton chunk of rock with an estimated diameter of 4 m grazed the Earth's atmosphere, reaching perigee about 60 km above Salt Lake City, Utah.(4) Because such a large object would not be completely decelerated by passage through the Earth's atmosphere,(5) the energy released by its impact upon the Earth's surface would have been equivalent to 20 kilotons of TNT—about the same as the Hiroshima/Nagasaki atom bombs. It has been estimated that such a collision should occur several times a century, with only 1% of the asteroids bouncing free,(4) as did the Salt Lake City meteor.

It is possible to generate an estimate of such impacts upon a global civilization if methods of retrieving or deflecting these objects are not pursued. For simplicity we will adopt a model for an eventual steady-state world population based upon some of the more optimistic initial projections of the "Club of Rome."(6) It will be assumed that the world population eventually levels off at 6 billion people, decentralizes, and covers most of the land (20% of the Earth's surface) with a uniform population density. The eventual population density of the Earth's land surface will therefore be about 60 people/km^2.

So far we have been lucky. Large meteorites have impacted in remote locations, at least in recent times. However, we can expect the impact of such a large meteoritic body to be similar to that of atomic bombs, at least in terms of immediate blast effects. The bomb that destroyed Hiroshima completely devastated 11 km^2; the less-effective Nagasaki weapon completely burned out 4.7 km.^{2}.(7)

Thus, we can expect an average of 300 persons to be killed by each impact of an August 10, 1972 sized meteorite upon the land. It also seems reasonable to expect at least one such impact to occur each century. This is likely to be a very conservative estimate. Larger objects such as the 1908 Tunguska "meteorite" have not been considered.(8)

It is possible to compare this conservative estimate of 300 persons killed per century with possible environmental consequences of various human activities. According to a critique of the "Rasmussen" report on nuclear safety,(9) the risk to an individual of being killed by an accident in 100 light-water nuclear reactors is so low that in a century we can expect a population of 6 billion persons to suffer 120 deaths from such a system.

It seems, therefore, that the risk to a population by meteoritic impact is comparable in magnitude to the risk experienced in a nuclear-powered world. It is now nearly in our power to retrieve or deflect large meteorites before they enter the Earth's atmosphere. Since enormous sums of money are being invested in alternate energy systems to reduce the risk expected from a nuclear world, investment of the much smaller sum required to develop an asteroid retrieval system seems justified.

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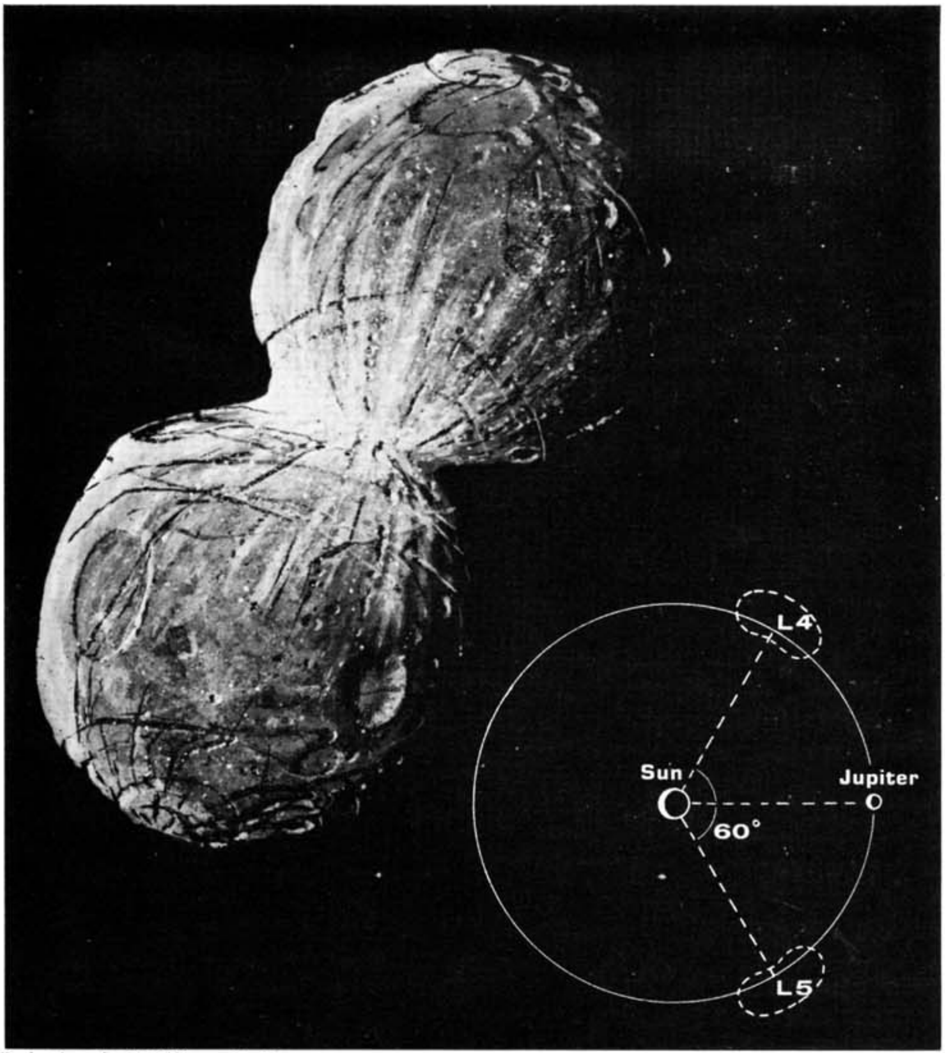
L-5 Hosts Giant Peanut

by Carolyn Henson



Painting by William K. Hartmann

Asteroids cluster in the Jupiter/Sun L-4 and L-5 libration points.

Although astronomers have yet to locate so much as a whisp of dust at the Earth/Moon libration points, the Jupiter/Sun L-4 and L-5 libration points are crowded with huge asteroids. Often called the Trojan points because their asteroids are named after the heroes of the Trojan War, these libration points may someday become the center of major mining activities.

Last November, astronomers William K. Hartmann of Tucson's Planetary Science Institute and Dale P. Cruikshank of the University of Hawaii announced the discovery of the most unusual Trojan body of all: 624 Hektor. Shaped like a giant peanut 180 miles long by 90 miles across, it may have been formed when two asteroids bumped into each other at speeds slow enough to weld them together.

Wags have proposed renaming the peanut-shaped asteroid "Jimmy," after U.S. President and former peanut farmer Jimmy Carter. Perhaps a namesake asteroid out at L-5 would encourage Carter to put a little more money into NASA's flagging space efforts.

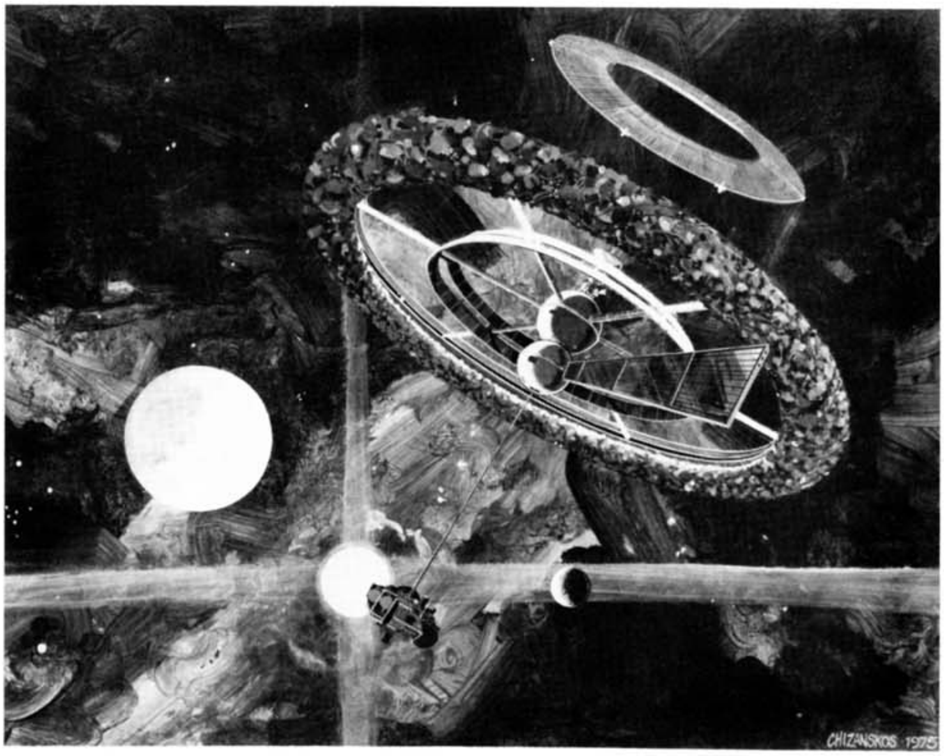
The Asteroids: Supply Stations for Elements

by Dr. Michael A. Pelizzari
Reprinted from **The Colonist,** *the Newsletter of the Texas L-5 Society.*

The Moon contains most of the elements that humans use in abundance. The ease of launching things from its surface will make the Moon an important source of these elements for building our first permanent outposts beyond Earth. But several elements are seen to be in very short supply there. As a result of terrestrial volcanic and hydrologic processes, trace elements often occur in concentrated deposits, making them accessible to miners. But similar deposits are unlikely to be found on the quiet, waterless Moon, making recovery of its trace elements difficult or impossible.

The elements carbon, hydrogen, chlorine, nitrogen, and possibly sulfur, among others, cannot be extracted from the Moon in sufficient quantitites to supply human needs. Must spacefarers import these elements from Earth? A "Stanford Torus" space colony would contain roughly a million tons of them, costing at least $15 billion to drag out of the Earth's "gravity well." Most of that cost is for carbon and for water, basic constituents of all life, and both completely missing from the Moon rocks sampled so far.

But hark! What light through yonder spectrophotometer breaks? 'Tis sunlight reflected from an asteroid which appeareth mightily like a carbonaceous chondrite of up to 5% carbon and 20% water—just what the Torus ordered! Hundreds of thousands of these mountain-sized objects orbit between Mars and Jupiter, while some forty of them (the so-called Apollo and Amor asteroids) have been observed on orbits much closer to Earth's. Although the origin of asteroids is still a mystery, their parent body or bodies have undergone more material differentiation than the Moon's surface. Valuable concentrations of trace elements can therefore be expected among the asteroids. If one with suitable composition and proximity can be discovered, it can be retrieved to provide some of the elements missing from the Moon. An electromagnetic mass driver (proposed to launch surface material into space) can be strapped onto an asteroid and used as a rocket engine, ejecting some of the asteroid's own mass to propel the rest into Earth orbit.



A "Stanford Torus" space colony which would contain about a million tons of the elements carbon, hydrogen, chlorine, nitrogen and others. While highly expensive to obtain from Earth, these elements could be obtained from asteroids.

Once the mass driver technology has been developed, retrieval cost of asteroidal mass could be as low as 20¢ per kg for an Earth-crossing asteroid 100 meters across. About 150,000 such objects are believed to exist, and it is simply a matter of "prospecting the skies" to find ones rich in the desired elements. Compositional information is obtained by reflectance spectrophotometry, a way of measuring how much light of each color is reflected by the observed object.

Besides carbon and water, the carbonaceous chondritic asteroids are likely to contain enough nitrogen and sulfur to satisfy human demand. This leaves chlorine as the only major element missing from the space resources likely to be tapped in the next 30 years. On a longer time scale, humans should be recovering even chlorine from outer space, perhaps by tapping the salty surface of Jupiter's most bizarre satellite, Io.

The estimated future demand for space resources is based on today's human consumption patterns, and does not take account of alternative consumption patterns peculiar to living in space, or the use of substitute materials as a means of striking a better balance between demand and supply. So, the reader is cautioned to take the numerical precision of this article with a grain of that Ionian salt!

Gas Entrained Solids—A Heat Transfer Fluid For Use In Space ©

by

H. Keith Henson
Analog Precision, Inc.

K. Eric Drexler
Massachusetts Institute of Technology

Part II of a two-part article.

Even without zero gravity test results, we can say a *few* words and write some simple equations about the design of radiators using gas entrained solids.

Assuming that low density gas streams loaded with fine solids are well behaved, i.e. they stay well mixed and do not exhibit slug flow or other undesirable characteristics, then the design of a gas entrained solids radiator will take off from a determination of the maximum velocity of the gas/solid mix which will not wear away the radiator from the inside.

Wear decreases essentially to zero when the particle velocity perpendicular to the wall, V sin α, is less than a constant, K. K is a function of the physical properties of the particle and the wall.[5]

$$K = \frac{\pi^2}{2\sqrt{10}}\, y^{5/2}\, \frac{1}{\sqrt{d}}\left[\frac{1-q_1^2}{E_1}+\frac{1-q_2^2}{E_2}\right]$$

where

Y is the elastic limit of the wall material,

E_1 and E_2 are Young's modulus for the wall and particle,

q_1 and q_2 are Poisson's ratio for the wall and particle.

d is the effective density of the particle.

Note that particle *size* does not enter the equation, allowing the size to be determined by other characteristics or thermal properties. Particle shape does enter the equation, however. Sharp corners on the particles have the effect of increasing the effective density. The physical properties of the solids will be determined by what is cheaply available, and radiator walls must be built of something easy to fabricate, most likely steel or aluminum. Steel unrefined from asteroids would be just about ideal. Aluminum has a very low yield strength for most available alloys, but it can be anodized which creates a tightly adhering, high yield point layer of aluminum oxide on the surface.

For materials likely to be used, the computed and experimentally determined values of K are of the order of 1 meter per second. In straight tubes no wear would be expected for velocities up to at least 10 meters per second. Wear is likely to occur where the tubes change direction or join headers. Either the velocity could be reduced at these points, or replaceable wear plates installed. Taking 10 meters per second as the velocity of the heat transfer fluid as it flows around the radiator circuit, a number of other factors can be developed from the velocity and simple physical and geometric concepts.

An interesting side effect of the use of gas entrained solids is that the density can be adjusted by the simple expedient of saying "when" as the dust is being poured in. The optimal density ρ is determined by:

$$\rho = \frac{4aR}{Vc\Delta T}$$

where:

R is the radiation rate in kW/m²

a is the aspect ratio (length to diameter) ratio of a radiator tube ($l/2r$)

V is the velocity through a radiator tube

c is the heat capacity kWs/kg°c ($\simeq 1$ for lunar dirt)

ΔT is the input minus the output temperature.

This funny looking expression comes from the contemplation of a single radiator tube of radius r and length l, Fig. D.

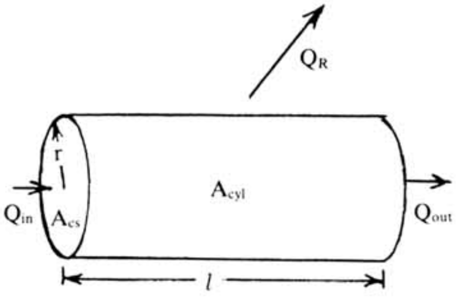


Fig. D.

The area of the tube and the radiation rate determine the heat flow Q_R.

$Q_R = A_{cyl} R$

The flow rate for heat in (out) is

$Q_{in(out)} = A_{cs} V \rho c T_{in(out)}$

where A_{cyl} is the area of the cylinder and A_{cs} is the cross section area of the tube.

Energy balance gives:

$Q_R = Q_{in} - Q_{out}$

or

$A_{cyl} R = A_{cs} V \rho c \Delta T$

solving for ρ,

$$\rho = \frac{4aR}{Vc\Delta T}$$

For an aspect ratio of 50, a radiation rate of 0.25 kw/m², velocity of 10 meters/second, and a ΔT of 20 degrees C, the density is 0.25 kg/m³. This is about 1/4 of the density of air. If the gas (assume oxygen) to solid mass ratio were 10%, the pressure would be 2.5% of an atmosphere. The 10% figure is arbitrary. If zero gravity tests show less is necessary, we would use less.

While the density depends on the aspect ratio, the mass per unit of radiation does not. Mass per unit of radiation depends only on the length of the individual radiator tubes, i.e. many small tubes or a few large ones of the same length may be used in a given radiator without changing the mass.

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If as above, $Vc\Delta T=200$, then m/R (in kg/kW) is equal to l (in meters)/200. This conclusion is in keeping with the logical arguments stated above. The 500 MW, one square kilometer radiator would use 1000 meter long tubes, and the heat transfer fluid would mass five kilograms per kilowatt.

There are limits on the range of the aspect ratio. Very short fat tubes would not allow the heat transfer fluid in the center of the tubes to come in contact with the wall resulting in poor heat transfer. As the tubes get longer and thinner, the necessary fluid density would approach that of solid rock!

A strange effect of adjustable density fluid (with a constant percentage of gas) is that the tube wall thickness turns out to be constant as the aspect ratio is varied. Changing the aspect ratio from 50 to 500 decreases the diameter of the example 1000 meter long tube from 10 to 1 meter. The fluid density needed for heat transfer would increase by a factor of 10 and, for the same ratio of gas to solids, the pressure would go up exactly enough to require the same wall thickness with the smaller diameter.

From the above, it can be seen that factors other than economy of wall material or fluid mass will determine the best tube aspect ratio. Low pumping losses and low leak rates and the efficient design of heat exchangers are some of these factors. The first two would be reduced by low aspect ratios and the attendent low pressure. High aspect ratios (resulting in high densities and high pressures) would make the heat exchangers less massive.* For the reference design, steel or aluminum stressed to 15,000 psi would be 1/8 mm or 0.005 inches thick. Meteoroid damage constraints are likely to require thicker walls.** If the walls were 0.008 inches thick (1/5 mm) the wall mass would be about 2kg/kW for aluminum or 4 kg/kW for steel.

Assuming lunar dirt or slag at $5 per kg, fabricated lunar aluminum at $25 per kg, and a factor of 2 for the headers, radiators operating at near the freezing point of water could be constructed for $150 per kW. Heat exchangers and fans might run another $100 per kW if they could also be constructed largely out of lunar materials. In this case, the reference design 500 MW waste heat radiator would cost $125 million. Using more optimistic numbers based on solar sail return of asteroid material, and advanced manufacturing techniques such as vapor phase fabrication, the cost might be brought down. Given filling for 50¢/kg, and steel for $1/kg, the radiator and headers would cost $13/kW. If the cost of fans, perhaps driven by small turbines, and heat exchangers roughly doubled this cost to $25/kW, the reference 500 MW radiator could be ordered from the Drexler/Henson radiator shop (motto, "No Job Too Large") for $12.5 million.

What are some of the implications these "dust filled radiators" might have on the early use of extraterrestrial resources?

To put these numbers into perspective, the investment in radiators per inhabitant of a space colony would vary from $20,000 to $2,000.

If engineering studies and zero gravity tests bear out these ideas, what are some of the implications for thermal cycle SPS designs and extra-terrestrial resource development?

One possibility, given the potential for lower temperatures (where water is liquid), is to use steam turbines. Gravity is normally used to sort out the liquid/gas phases in boilers and condensers. The boiler problem can be avoided by operation at supercritical temperatures and pressures. This might not be necessary as experimental boilers have been built where water was introduced at the top and steam removed from the bottom. The condenser may be a little trickier. We envision the steam turbine exhausting into a large drum. Tangential cold water sprays would provide the condensing surface and impart enough angular momentun to the condensate for it to swirl around the inside wall of the drum shaped condenser. Scoops placed in the flow would divert the condensate into pumps.

Condensate flow would be split, with some going to the solar boiler and the rest to a heat exchanger where the waste heat would be transferred to the gas entrained solids.

A steam SPS would look somewhat different from the current thermal SPS designs. Of course, the radiators would dominate the appearance. But more interesting might be the use of a large number of turbines, 1/4 GW or smaller. Because high heat fluxes can be carried by small mass flows of steam and boiler feed water, a few heat absorber cavities might supply steam for a number of turbo-generators spread out at intervals over the radiator surface area. Radiators and turbines might be located behind the sunlight collector area.

If there is any merit in these concepts, (and a considerable amount of engineering and space testing will be needed to tell) there are some very nice characteristics of steam turbines. One is that they present a low development risk. You could probably order them from General Electric today. Another is their high efficiency. At an easy to obtain 40%, their efficiency is about twice the theoretical maximum for silicon solar cells and roughly five times the eight percent now projected for a photovoltaic SPS. Of course, cost, not size is the determining factor, but counting the radiator area, a low temperature thermal SPS would have only 60% of the area of a photovoltaic SPS.

What are some of the implications these "dust filled radiators" might have on the early use of extraterrestrial resources? One possibility, if low cost asteroidal steel can be made available, would be to consider building SPSs at a space manufacturing facility which initially has no chemical processing at all.

For an intermediate step, with some SPS materials supplied from Earth, the rock dust part of the mass of a steam turbine SPS might be as much as 50%. The "do it from the ground" proponents make a good case that it's a long way from lunar rock to finished SPS parts. But, if all you need to make that rock useful for a large part of the mass of an SPS is a small vibratory ball mill, or even a screen, it is going to be hard on their consciences not to take a serious look at the early use of extraterrestrial resources.

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Acknowledgments:

The authors appreciate the assistance of Gorden Woodcock for technical advice and Annita Harlan for expert editing.

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We may be able to have our cake and eat it too. The solid fraction could be largely separated from the gas prior to entering the heat exchanger and the gas (which carries little heat) by-passed around the heat exchanger and reintroduced to the flow.

***Ways to find and fix leaks.*

1) Put a lot of sized rubber balls in the radiator to plug leaks (a passive method).

2) Use molecular beam cameras mounted out on long struts to locate leaks. A 1 kg/day leak would be fairly easy to spot with an electron beam scanning of a fresh, active metal surface.

3) Build a tube crawler which could be directed manually or by computer to find and fix leaks by plugging them with a sheet metal screw or pop rivet.

NEWS BRIEFS

The Office of Technology Assessment (OTA), one of the U.S. Congress' fact-finding arms, will award $400,000 in contracts to study space technology applications. Remote sensing, communications and space processing manufacturing will be emphasized.

At the request of the Senate Commerce Committee, another OTA group is evaluating solar power satellites. This OTA study was first proposed by futurist Barbara Marx Hubbard in a Congressional resolution in 1978.

These two studies represent the first time the OTA has studied space activities. OTA was founded in 1973.

Between June 6 and August 20, special briefings for educators will be held three times each week at Johnson Space Center on Monday, Wednesday and Friday at 10 AM. Topics to be covered include lunar science, Landsat and the space shuttle. Free materials will be available at each session, which will last two hours. Attendance will be limited to the first 35 to register for each session. For more information call (713) 483-4241 or write to James Poindexter, Educational Progams Officer, Public services branch (AP4), NASA Johnson Space Center, Houston, TX 77058.

The space shuttle has been further delayed by main engine troubles, forcing NASA to reschedule at least four or five commercial payloads for expendable boosters. There is only a 50/50 chance that the first shuttle will be able to fly by June 1980.

On July 1, Thomas A. Mutch of Brown University was appointed NASA's Associate Administrator of Space Science. He succeeded Noel Hinners, who had resigned March 31.

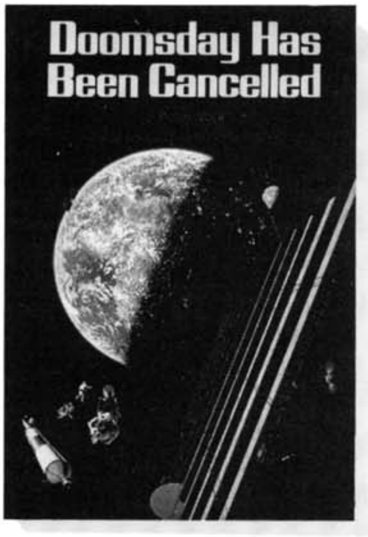
Mutch has been leader of the Viking lander imaging team and a member of the Lunar Science Review Board. His responsibilities as Administrator for Space Science will include working with the Congresspeople who fund space sciences.

The U.S. House Appropriations Subcommittee on Military Construction has deleted the funds needed to install space shuttle launch facilities at Vandenberg Air Force Base. These launch facilities would enable the shuttle to reach polar orbits. These orbits are needed for spy and other military satellites as well as for Earth Resources satellites. If launched from Kennedy Space Center the shuttle would follow the heavily populated Eastern Seaboard, opening the possibility of a major disaster.

If this cut is upheld by the Senate, it will delay the first polar shuttle launch until at least 1984 and will force the government to buy $200 million worth of Titan launches to orbit already scheduled payloads. The Vandenberg shuttle facilities were budgeted for $78.2 million this year.

Solar power satellite boosters are rejoicing over the nomination of John Deutch for Undersecretary of Energy in the U.S. Dept. of Energy. Deutch, formerly an M.I.T. chemistry professor and a Rand Corp. and U.S. Dept. of Defense consultant, is well known as a progress-oriented, optimistic backer of energy R & D. Researchers say that Deutch is expected to give power satellites an even break.

Book Reviews



Reviewed by Chris Peterson
Reprinted from **Hubcap,** *the Newsletter of the New England L-5 Society.*

What do you say when the question comes up, "Why are you interested in this space stuff, anyway?" Most of us are pretty good at explaining why space utilization is a good idea economically but poor at explaining why it's important in other respects for the human race as a whole.

In a non-technical, even philosophical tone, J. Peter Vajk's **Doomsday Has Been Cancelled** examines the possibilities of space from many different perspectives. He explains why it's humane and socially desirable for a wealthy, highly developed nation to allocate some of its resources for space development rather than attempting to first fulfill the basic survival needs of every inhabitant of Earth. He also describes, in terms a layman can understand, how a space settlement program could reduce the threat of nuclear war, increase agricultural production, and improve the standard of living for everyone. The book focuses throughout on methods of continuously improving the human condition, and thus succeeds in demolishing the currently popular limits-to-growth and doomsday scenarios.

It is rare to find a scientist (here, a physicist) who can write so well. It is even rarer to find one who can write so effectively for an audience that has been traditionally hostile to the idea of space utilization. Although the book has wide-ranging appeal, a careful look reveals that Vajk seems to be addressing the concerns of those holding anti-technology, "small is beautiful," pro-decentralization perspectives ("soft-technologists," as they sometimes call themselves). He makes a persuasive case that space development is a cause these people should adopt. (He is right, of course. They, like us, are interested in improving the quality of human life. Vajk simply points out that utilization of space is the best way to achieve that goal.) And since his publisher, Peace Press, seems to cater to these interests (their list of publications includes such titles as **The Art of Zen Meditation, Chinese Healing Arts, Mysterious Herbs and Roots, Solar Cookery,** and **Survival Greenhouse**), many "soft-technologists" will be exposed to Vajk's book.

However, **Doomsday Has Been Cancelled** is not just for the "soft-technologists." Since this book is both highly idealistic and easy to read, it's the perfect book for those involved in the space movement to have handy when in need of inspiration or reinforcement. It is ideal for times like just before an L-5 meeting when you don't feel like venturing out in the rain or the night before testifying to a congressional committee on why they should include more funds for NASA in an austerity budget. Vajk's book will remind you just how important space utilization is—for all of us.

Doomsday Has Been Cancelled can be ordered from Peace Press, Inc., 3828 Willat Ave., Culver City, Ca., 90230, for $7.95 (plus 60¢ for shipping and handling).

Clarke's "Hyperfilaments" Fishing in Space?

by Ed Bas

Imagine a spool of fishing line, thin yet tough enough to slice your finger when you go to break it. Imagine fishing line thousands of times thinner, molecularly engineered for perfect, flawless crystalline arrangement, fishing line spun from metal and able to carry a charge. Interesting, but what's the point?

Toss the concept to a veteran science fiction writer like Arthur C. Clarke, and the idea turns into an avalanche.

Science fiction is the literature of ideas. You can read it for amusement and file it aside as you go back to reality and **Aviation Week and Space Technology.** But Clarke deserves better. For non-fans, Clarke co-authored **2001; a Space Odyssey** and, in 1948, **The Promise of Space.** He is one of the two or three most-honored science and science fiction writers, pioneering the concept of communication satellites before any existed.

When Clarke says something, it's good to stand up and listen.

In his latest novel, **The Fountains of Paradise,** Clarke begins with the concept of a hyperfilament. Manufactured in zero-gravity conditions of the first space colonies, the molecules-thick fiber is an engineer's dream: a perfect crystal structure is produced without gravity pushing itself in a search for randomness.

So what? Well, Clarke supposes, this metallic hyperfilament could carry an electrical charge, right? Suppose you had enough of such a filament to stretch from a place on the Earth up to a satellite anchored in geosynchronous Earth orbit? With near-unlimited electrical energy from Sunsats, you have the potential for the world's largest elevator—or bridge, as Clarke's main character prefers to call it. You have a relatively cheap, exhaustless Heavy Lift Launch Vehicle—and one probably more suited to the 21st century than the fat, inefficient chemical models which may be the only alternative to the space shuttle.

Clarke doesn't pretend that a snap of the fingers and handy-dandy spool of hyperfilament would do the trick. Molecules-thick or not, you're going to be dealing with an awful lot of mass in a "bridge" that long. Clarke has done some calculations to show that an anchor mass of the other end of this bridge would have to be bigger than any orbiting space station—it would have to be near asteroid-size.

For the Earth-end of the bridge, Clarke proposes a spot on the equator, preferably a high mountain with good weather.

The novel bears reading for more than its technical whiz-bang. But it also deserves careful reading by engineers, space scientists and potential space colonizers. Clarke seems to be saying, "Yes, of course we'll have space colonies. But now let's leap ahead and speculate on what will follow."

Another science fiction writer and visionary, Robert Heinlein, wrote about the moon's first mass-driver back in 1967, in **The Moon is a Harsh Mistress.** It was years before O'Neill and the MIT mass-driver models.

Both **Fountains** and **Mistress** grabbed hold of space economics and wrapped them in adventure stories. Both shout that space will belong to people only after they are capable of reaching it as easily as they pull onto the freeway to go home from work every night.

O'Neill Shows the Way

by Ken McCormick

When the Congressional Clearinghouse on the Future invited Dr. Gerard O'Neill to speak to Congressional staff persons on June 27, they were treated to an exposition of technology and even philosophy. O'Neill outlined a plan for "Near Term Uses of Non-Terrestrial Material for Human Benefit" citing various studies including one of his own projects. He also expressed thoughts on the eventual effects on society of *not* moving into space.

> *The tensions involved in the zero-sum game of "I win — you lose" are very much a part of our lives; they're a part of our lives every time we get in a gas line...*

O'Neill's presentation dealt with work which has been completed during the last year on the use of lunar materials in the construction of solar power satellites. O'Neill called SPS the "present apparent largest single result that we could have from using this material," but he also explained that there could be other uses for lunar-derived construction materials, such as for very large communications antennae. Studies indicate that at least 5,000 to 15,000 tons per year of large objects could be needed in space for the next 30-year period, said O'Neill. An SPS program would require 120,000 tons per year.

The work he outlined was aimed at using existing technology to place in orbit one power satellite per year using the Space Shuttle as the only booster to low Earth orbit. This can only be done through the use of non-terrestrial materials (NTM), since an SPS would require 20 times the mass that the present shuttle program could launch in a year's time.

O'Neill referred to three NASA-sponsored studies which were completed this spring.

A study by General Dynamics/Convair established the overall economics of lunar materials use. The two conclusions of the study which O'Neill feels are most significant are that at least 90% of the mass of an SPS could be constructed from lunar materials, and that the use of lunar materials would reduce the overall cost of SPS without delaying the implementation of an SPS program. The study has been verified by an in-house review at Johnson Space Center.

An MIT study of the fabrication of large objects in space concluded that at least 96% of the mass of an SPS could be constructed from lunar materials. This also supports the conclusions of the aforementioned study.

A study by the Lunar and Planetary Science Institute in Houston examined the technology of the chemical processing of lunar soil and concludes that a processing plant in space would have a throughput of 100 times the mass of the plant itself per year. In other words, the plant would produce its own weight in usable elements every three to four days.

Dr. O'Neill then outlined one possible scenario for an NTM utilization project which he and his colleagues had worked out over the past year. In this "bootstrapping" approach, a 125-ton electromagnetic mass-driver, a chemical processing plant, and a plant for fabricating solar cells would be placed on the lunar surface by the shuttle, an orbital transfer vehicle, and a lunar lander derived from the Apollo program vehicle.

Since the solar cell array which would provide power for the mass driver would be ten times as massive as that device, lunar silicates would be used to gradually build up a 60 megawatt power array. The power array would then enable the mass driver to launch 300,000 tons per year of lunar materials. These 300,000 tons would provide about 100,000 tons of finished products in orbit.

Thus, through "bootstrapping" the lifting of 6,000 tons over a two- or three-year period from the Earth's surface would ultimately provide about 100,000 tons of construction material in space per year.

The funding level for this research has been at about one part in a million of the federal budget. "The reason that we can do so much with so little," said O'Neill, "is that basically we're not trying to push in any new science. There is nothing here as far out as, let's say, fusion power. This is straightforward engineering carried out in the way we've done it before."

Dr. O'Neill's elegant exposition seemed to have been wasted on many of the assembled staffers. One staffer asked if the people who had conducted the studies had remembered that a human work force would have to be maintained on the Moon. O'Neill assured him that they had remembered that and had included it in their calculations. Another person expressed the fear that the removal of lunar soil might have a grave effect on tidal or other forces. O'Neill pointed out that 300,000 tons is not a great amount of material when compared with the total mass of the Moon, but added that "lunar ecologists" such as himself see the asteroids as being the best long-term reserve.

> *If your fundamental belief is that humanity is evil, then the only way that you can deal with it is to hedge it around with a very rigid set of laws.*

Near the end of the question-and-answer period, Dr. O'Neill expounded some philosophical underpinnings of his interest in space colonization. "Think of two alternative situations," he said. "One is that we stay within the very tight set of bounds of our present planetary biosphere. We already see the effects of this confinement within the biosphere with the increase in population that's going on. There was a recent study, for example, indicating that the number of wars is now about four times as high as it was 50 or 75 years ago. The tensions involved in the zero-sum game of 'I win—you lose,' are very much a part of our lives; they're a part of our lives every time we get in a gas line...

"Such quasi-religious writers as Huxley and Zamiatin have looked into the question of the long-term implications of the steady-state society. They conclude that it must be highly rigid, and that rigidity must extend into the spiritual realm as well as the physical. I think we see that effect already around us now, because as soon as you begin to put tight bounds on something, then there will always be millions of people who will jump in and tell you how you have to run your life... This gives all of the people who'd really like to run other people's lives the license to legitimately do so, and that's what happens in a totalitarian state.

"So I think that the chances of maintaining ourselves within this finite biosphere and also extending personal freedom of choice are very, very small.

"On the other hand, . . . [the outcome of] the movement into space [would be] a very dispersed society . . .

"I think that you're dealing in the one case with a very great pressure toward rigidity, stagnation and monotony. In the other, you're opening up a very large number of paths for the development of small human movements — tens of thousands or even as few, perhaps, as 20 or 50. The *Mayflower* colonists were very small in number, but what they did was rather important. There could be many, many sets of *Mayflower* colonists in space, doing a wide variety of different things. Our ancestors were non-conformists. I think that there would be the freedom to non-conform in that new situation.

"To me that does approach a religious comparison, and certainly a spiritual one. If your fundamental belief is that humanity is evil, then the only way that you can deal with it is to hedge it around with a very rigid set of laws. If your fundamental belief is that if given a reasonable chance, ordinary people will develop in interesting ways and do interesting things, then you will want to give them the maximum opportunity to do so. That gets at the root of humanity, if not of religion."

It was not readily apparent how receptive legislative aides were to Dr. O'Neill's arguments.

Reading News

Aviation Week and Space Technology

Reprinted from **Hubcap**, *the Newsletter of the New England L-5 Society.*

One magazine that is a must for those interested in the latest developments in the space industry is **Aviation Week and Space Technology** (published by McGraw-Hill). **Aviation Week** regularly features a major section on space technology including news about the Soviet space program, the current Shuttle news (or its most recent troubles and delays!), other NASA developments, and recent activities in industry (as well as the current news in the aviation industry). Also, it features an "Aerospace Calendar" which lists all the major conferences on aviation and space developments.

Aviation Week not only reports scientific and engineering developments, but also reports on military, political and industrial activities. Since it is published weekly, the news covered is always current. In one week's issue there was, for example, an extensive article on "Shuttle Mission Control Training" reporting on the mission control center, various shuttle preparations, and even some of the latest astronaut training programs at Marshall Space Flight Center. It also included several brief articles on recent Soviet activity, payload insurance for the Shuttle, and Landsat news.

Most libraries subscribe to **Aviation Week** (if your local library does not, you might suggest they start a subscription). However, this magazine is very popular and doesn't remain in the library long.

If you are interested in subscribing, the rate is $33.00/yr. (with reduced rates for 2 or 3 year subscriptions). Write to:

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The Martian Landscape

Over 150 pictures, several in full color, taken on the surface of Mars by the Viking 1 and 2 landers. $12.00

Watch Upon a Star

Describes the mission and activities of the Space Environment Services Center, which is charged with monitoring the Sun for events which affect life on Earth, and discusses the major physical and behavioral characteristics of this, Earth's own star.

Skylab EREP Investigations Summary

The scientific and technological achievements from the Skylab space program are numerous and include new knowledge of solar phenomena, of human capability for long-duration space flight and of the Earth through the sophisticated sensors that comprise the Earth Resources Experiment Package. This book summarizes the analytical results of 139 investigators who used EREP data in their study of problems in the areas of agriculture, range, and forestry; land use and cartography; geology and hydrology; and oceans and atmosphere. Contains many color photographs.

Princeton Space Manufacturing Conference Papers Available

The most up-to-date technical papers on the habitation and industrialization of space are available from AIAA, 1290 Ave. of the Americas, New York, NY 10019 for $1.75 each for AIAA members or $2.50 each for AIAA non-members. The available papers, which were presented at the May '79 Princeton Space Manufacturing Conference, are:

"Current Space Habitat Legal Developments," Edward R. Finch, Finch & Schaefler (79-1374)

"Carbon Dioxide Electrolysis Using a Ceramic Electrolyte," Richard J. Williams, Thomas Erstfeld, NASA-Johnson Space Center (79-1375)

"Excavation Costs for Lunar Materials," W. David Carrier, III, Lakeland, FL (79-1376)

"Electrostatic Separation of Lunar Soil," Ian Inculet, University of Western Ontario (79-1378)

"Chemical Processing of Lunar Materials," Robert D. Waldron, Lunar & Planetary Institute (79-1379)

"Electrochemistry of Lunar Rocks," Larry A. Haskin, Washington University (79-1380)

"Glass and Ceramics from Lunar Materials," John D. Mackenzie, Rex Claridge, UCLA (79-1381)

"Gas Entrained Solids—a Heat Transfer Fluid for Use in Space," H. Keith Henson, Tucson, Arizona, K. Eric Drexler, MIT (79-1382)

"Space Manufacturing and Public Policy Formulation," John Logsdon, The George Washington University (79-1383)

"Education for the Era of Space Industrialization," Kerry M. Joels, Smithsonian Institution (79-1384)

"Improving the Justification for Space Industrialization," John G. Barmby, Vienna, VA (79-1385)

"An Analysis of the Socio-Political Status of Efforts Toward the Development of Space Manufacturing Facilities," Robert D. McWilliams, University of Mississippi (79-1387)

"The Role of Public Interest Groups in Space Policy," Charles Chafer, Foundation for Public Affairs (79-1388)

"Financing Alternatives for Space Industrialization," J. Peter Vajk, Science Applications, Inc. (79-1389)

"The Economics of Strikes and Revolts During Early Space Colonization," Mark M. Hopkins, Rand Corporation (79-1395)

"Overview and Outline of Mass-Driver Two," Gerard K. O'Neill, William R. Snow, Princeton University (79-1396)

"Cryogenic Service Station for Mass-Driver Two," Kevin Fine, Henry Kolm, Peter Mongeau, Frederick Williams, MIT (79-1398)

"Linearization of Mass-Driver Geometry by Bucket Steering," Jonathan Leavitt, Princeton University (79-1399)

"Electromagnetic Propulsion," Henry Kolm, Kevin Fine, Peter Mongeau, Frederick Williams, MIT (79-1400)

"Duct-Burning Turbofan for an Earth-to-Orbit Vehicle Booster," James A. Martin, Shelby J. Morris, Jr., NASA-Langley Research Center (79-1405)

"Systems Integration in the Development of Controlled Ecological Life Support Systems," John L. Carden, Georgia Institute of Technology (79-1406)

"Waste Treatment Options for Use in Closed Systems," Michael L. Shuler, Cornell University (79-1409)

"Development of Space Manufacturing Systems Concepts Utilizing Lunar Resources," Edward H. Bock, General Dynamics/Convair (79-1411)

"Lunar Resources Utilization—An Economic Assessment," Robert Risley, General Dynamics/Convair (79-1412)

"New Methods of Solar to Radio Frequency Electromagnetic Energy Conversion," John W. Freeman, William Colson, Sedgwick Simons, Space Power Institute (79-1416)

"High Performance Solar Sails and Related Reflecting Devices," K. Eric Drexler, MIT (79-1418)

"Solar Power Satellite Beam Disturbance of the Ionosphere," James Drummond, Power Conversion Technology, Inc. (79-1422)

"Atmospheric Attenuation of Centimeter Microwaves," Warren Ziegler, Goddard Institute for Space Studies (79-1423)

"Guidance Trajectory and Capture of Lunar Materials," T.A. Heppenheimer, Center for Space Science (79-1424)

"Optical Scanning of Moving Payload Positions," Rainer Malzbender, Princeton University (79-1425)

"Light Pressure and Solar Wind Perturbations to Payload Trajectories," Brian P. Von Herzen, Princeton University (79-1426)

"Aesthetic Considerations in Bernal Sphere Design," Marjorie L. Stuart, Plandome, NY (79-1428)

"The Value of Anthropology for Space Settlements," Darlene Thomas, Lockhaven State College (79-1429)

"Consciousness Alteration in Space," B.J. Bluth, California State University (79-1430)

"Asteroid Prospecting and Retrieval," Brian T. O'Leary, Princeton University (79-1432)

"Low Thrust Alteration of Asteroidal Orbit," David Ross, Stanford University (79-1433)

"Collisional Orbital Change of Asteroidal Materials," Cliff Singer, Princeton Plasma Physics Laboratory (79-1434)

"The Search for Asteroids in the L-4 and L-5 Libration Points in the Earth-Sun System," R. Scott Dunbar, Princeton University (79-1437)

Please use the paper number (in parentheses) when ordering.

Announcements

The High Frontier Trading Post

A new feature of the **L-5 News** beginning in October, The High Frontier Trading Post will give L-5 members an opportunity to get in touch with one another. Each noncommercial member is entitled to one free ad per year, not exceeding 40 words in length. Extra or longer ads will be charged at a rate of $ .20 per word (or $4.30 per square inch). Please allow 3-4 months for your ad to appear. All ads will be subject to editorial review. Send your ad to:

The High Frontier Trading Post
The L-5 Society
1620 N. Park Ave.
Tucson, Az. 85719

FutureExpo

FutureExpo, described as "a vision of the future," is to be held on October 4-7, 1979 in the San Mateo Fairgrounds, San Mateo, California. People with new technology and innovations are urged to participate and present their ideas to the public. For more information contact:

The Griffin People Inc.
4300 Stevens Creek Blvd. 275
San Jose, CA 95129
(408) 247-7415

"Issues for Tomorrow"

This will be the theme of the southeastern regional conference of the World Future Society chapters to be held October 12 and 13 at Georgia State University's Urban Life Center in Atlanta, Georgia. Cosponsored by Futures Network and the L-5 Society, the conference will provide a forum for analysis and debate among policy makers and program implementers representing universities, professionals, government, business and industry. For more information, contact Estelle Greene, Conference Coordinator, Division of Public Service, Georgia State University, University Plaza, Atlanta, Georgia 30303. Telephone (404) 658-3466.

Lunar Electrochemistry Workshop

The Electrochemical Society and the Lunar and Planetary Institute are cosponsoring a three-day workshop devoted to the adaptation of techniques in electrochemistry to the processing of lunar materials on an industrial scale in space and on the Moon. The meeting is presently planned to be held September 12-14, 1979 at the Lunar and Planetary Institute. Participation by members of the lunar and planetary community is encouraged. Many of the technical topics will be of relevance to the lunar sample research community. Your assistance is requested in bringing this workshop to the attention of colleagues in the fields of physical chemistry, chemical engineering and aerospace engineering. Electrochemical systems offer the possibility of obtaining industrial feedstocks from lunar and eventually asteroidal materials with minimum complexity and high reliability. For more information about this workshop contact either Dr. David R. Criswell (713/486-2152) or Dr. Robert D. Waldron (713/486-2158) at the Lunar Planetary Institute, 3303 NASA Road One, Houston, TX 77058.

International Aviation and Space Medicine Congress

The Organizing Committee of the XXVIIth International Congress of Aviation and Space Medicine, to be held October 8-12, 1979 at the Philippine Plaza Hotel, Manila, reports registrations are still being received from throughout the world. Organizing Committee Chairman Augusto E. Hocson, M.D., has announced that a large number of world leaders in Aviation and Space Medicine will be in attendance. Dr. Hocson added, "The Congress is open to paramedical personnel and other professionals involved with Aviation and Space Medicine, as well as physicians and surgeons specializing in the discipline. In addition, a highlight of the program of the 1979 Congress will be the participation of American astronauts and Russian cosmonauts."

Due to the limited amount of time prior to the opening of the Congress, the Organizing Committee is urging all persons planning on attending the Congress to immediately contact the Congress Secretariat, XXVIIth International Congress of Aviation and Space Medicine, P.O. Box 7675 Airmail Distribution Center, Domestic Airport Road 3120 Metro Manila, Philippines. Cable Address: AEROSPACE.

Moon Glass

A workshop entitled "Glass and Ceramics Industry in Space Based on Lunar Materials" was held at the Lunar and Planetary Institute on April 14-16. It was attended by representatives from the glass industry, university departments specializing in glass and ceramic products, automation and Spacelab research projects, and the Los Alamos Scientific Laboratory. They reviewed the many products that can be made from lunar materials and, in particular, analyzed the construction of a glass production facility on the Moon which could provide glass and ceramic inputs to a space power station. It was estimated that 40 people and 500 tons of equipment placed on the Moon could be used to create a glass plant with an output of 30,000 tons per year. Dr. John MacKenzie, University of California, Los Angeles and Dr. David Criswell, Lunar and Planetary Institute were co-chairmen.

A summary of the workshop can be obtained for $2.00 from:

The Lunar and Planetary Institute
3303 NASA Road One
Houston, TX 77058

Center to Study Life in Space

Many space enthusiasts feel that economic and social planning is lagging far behind the technological planning that may soon place large numbers of humans in space.

The Center for the Study of Human Communities in Space is being developed at Niagara University in an effort to overcome this planning lag. Under the direction of Professors Stewart Whitney and William MacDaniel, the Center is amassing a mailing list of interested scholars from a variety of social science fields as well as from the natural and physical sciences.

The goal of the Center is to develop a nucleus of informed scholars who will be prepared to meet the social planning needs of the national space program with expediency and efficiency.

The Center will be taking a major step toward achieving this goal next year when it sponsors a national conference aimed at identification of the numerous factors that may influence alternative approaches to establishing space settlements. The conference will also attempt to organize an efficient approach for incorporating these parameters into our future space planning efforts.

Those wishing to learn more about this effort may contact: Center for the Study of Human Communities in Space, Niagara University, NY 14109.

Space Solar Power Review

Volume 1, Number 1 of the **Space Solar Power Review** is to be published in the fall of 1979. It will be a quarterly journal dedicated to innovative research in the physical and social sciences on space deployed energy retrieval and transmission systems.

Space Solar Power Review will accept for review by referees manuscripts presenting previously unpublished information on any aspect of space solar energy research, measurement, development or application. These may take the form of scientific or engineering papers describing original studies (4000 to 6000 words), or shorter technical notes (600 to 2000 words), state-of-the-art reviews, and topical reports. News items and reviews of publications in this field are also accepted.

Manuscripts should be sent in quadruplicate to Dr. John W. Freeman, Editor-in-Chief, **Space Solar Power Review**, Rice University, P.O. Box 1892, Houston, Texas 77001 U.S.A. Only manuscripts in English can be accepted.

The **Space Solar Power Review** will be published on behalf of the Sunsat Energy Council by Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, New York 10523.

Science and Technology Hearings

Senator Howard W. Cannon (D-Nev.), Chairman of the Senate Committee on Commerce, Science, and Transportation, announced the availability of a Committee publication of hearings on the Office of Science and Technology Policy, held before the Subcommittee on Science, Technology, and Space on March 7 and 21, 1979.

These hearings were conducted to review implementation of the National Science and Technology Policy Act of 1976. The Act has four main objectives: to provide a statement on the National Science and Technology policy, to provide the President with scientific and technological advice, to provide a mechanism for management of Federal scientific and technological activities, and to provide a mechanism for developing a national science and technology agenda for Government, industry and the general public. The hearings assessed the effectiveness of the Office of Science and Technology Policy in carrying out these provisions. The hearings also examined the health of our national scientific community.

Persons interested in receiving a copy of the hearings should send a self-addressed mailing label to the Committee on Commerce, Science, and Transportation, Subcommittee on Science, Technology, and Space, United States Senate, Washington, D.C. 20510. Questions concerning the material should be directed to Steven Flajser or Stephen Merrill, Professional Staff Members, (202) 224-9351.

Voyager News Release Films

There are four 1979 NASA News Release 16 mm color films which can be purchased from:

Stock Film Laboratory Branch
Audiovisual Archives Division (GSA)
1411 S. Fern Street
Arlington, VA 22202
(Mr. Frank Stevens 703/557-1115)

The New Voyager films are:

NASA HQ 79-426 Voyager: Jupiter Encounters 1979

Approximately 8½ minutes, $86

A descriptive sound film about the objectives of the Voyager mission

NASA HQ 79-427 Jupiter Rotation

Approximately 2½ minutes, $26

A brief color film showing rotation of Jupiter as actually observed by Voyager I.

NASA HQ 79-428 Voyager I Encounter Film

Approximately 3 minutes, $30

A computer animation film depicting the flyby of Voyager I at Jupiter and its Galilean satellites.

NASA HQ 79-429 Jupiter's Atmospheric Dynamics

Approximately 2½ minutes, $26

A color film showing the atmospheric circulation observed on Jupiter by Voyager I during January 1979. Made from images of Jupiter taken every 10 hours of the same longitudinal region, including the Great Red Spot.

Orders must be received in writing and be accompanied by payment. The prices given above are only approximate. Exact prices can be obtained by phone. The cost estimates given are for projection prints, not master copies or negatives. Films are printed to order. It takes about seven days to fill an order.

Two photo suppliers have made lists of the Voyager pictures available: MMI Corporation, 2950 Wyman Parkway, Baltimore, MD 21211 and Photographic Illustration Co. (PIC) P.O. Box 6699 Burbank, CA 91510. Many other dealers are offering Voyager pictures (see recent issues of **Astronomy** and **Sky and Telescope**). The recent issue of **Astronomy** (May 1979) has several color reproductions of the pictures along with descriptive text of the mission. The Photo/Map Library at the Lunar and Planetary Institute (LPI) has sets of slides and copies of the films available for loan. Please contact Ron Weber, LPI Photo/Map Library, 713/486-2172 for information about their availability.

Encounter Dates

Voyager 2	Jupiter	July 9, 1979
Pioneer II	Saturn	September 1, 1979
Voyager 1	Saturn	November 12, 1980
Voyager 2	Saturn	August 27, 1981

Inside the L-5 Society

East Coast L-5 Conference a Success

Reprinted from **Frontiers**, *the newsletter of the Upstate Space Alliance.*

by Bruce Voris

The first east coast L-5 conference, hosted by the Space Futures Society, was held in Philadelphia on May 19 and 20. The conference started off with a screening of the Libra Colony, a film about the first space colony. Set in the near future (2000) the film presented a pessimistic outcome of the current oil crisis. By building solar power satellites from inexpensive lunar ore, the Libra Colony presented an ultimate solution to the energy problem.

Following the film, Dr. Brian Jones of Villanova University gave a talk on "Social Systems in Space Colonies." Dr. Jones first discussed some of the apparent causes for the present dehumanization of society and suggested that one of the main causes was the large size of bureaucracies inherent in a large modern society. He concluded that the smaller sizes of colonies in space would provide a much more conducive atmosphere for the development of stable communities. He was also encouraged by the possibility of examining the various types of social systems that could be set up on an experimental basis.

The evening dinner meeting provided an excellent opportunity for all the L-5 chapter members to get acquainted and to discuss their local chapter projects.

On Sunday morning, the conference continued with a "brainstorming" session focusing on key aspects of space development. Sources for funds that were mentioned included the Arab oil barons; instead of spending their money on gold plated Mercedes, they could invest in SPS. Other topics were tossed around. It turns out that the defense department is interested in O'Neill's mass-driver; they want to use it to accelerate artillary shells to mach 3. The second working mass-driver has almost been completed. This version of the mass-driver was designed to use superconducting magnets, operate in a vacuum, and achieve accelerations of 500 gs.

Ken McCormick gave an informal talk on how to influence Congress, and discussed some of the workings of that revered institution. He suggested that although a personal visit to a representative was not all that bad, one got the impression that congressmen at times do not like to be imposed upon by a lowly constituent. Ken said that writing a letter to the representative's office was nearly as effective as a personal visit and at times better, since a visit is a one-shot affair, that can leave a bad impression if not handled with care. He stressed that letters do count. For each letter that is received, it is assumed that there are at least 10-100 people in the district that feel the same way.

The conference ended with exchanges of addresses and commitments for better communications in the future.

Dr. Brian Jones of Villanova University. (Photo courtesy of David R. Jones, Jr.)

Errata

An incorrect address was listed for the Fresno L-5 Chapter in the May issue of the **L-5 News**. Mail correspondence should be sent to:

Chris Gudger
1440 E. Griffeth Way #215
Fresno, CA 93704

Mr. Gudger can be reached at (209) 225-0768 and the Fresno Chapter president, Edith L. Percy, can be reached at (209) 226-8480.

Virginia Tech News

The Virginia Tech Chapter L-5 Society has elected new officers for its third year as a university-recognized organization. Frank Quinto, an Aerospace and Ocean Engineering major was elected president for the upcoming year. Other officers include John Schneider, vice president; Martin Manley, secretary; and David Haig, treasurer.

The upcoming year will see the chapter continue as a clearinghouse of information for the university and surrounding communities, according to Quinto. A wider variety of slide lectures are planned for presentation to schools and interested groups along with other projects.

The Virginia Tech Chapter will be following through with its planned Space Week activities which include movies, lectures, displays, and the Deputy Project Manager of the Viking program, Cary Spitzer, speaking on the success of the Mars landing on its third anniversary.

Quinto summed up by saying it should be an interesting year for the chapter and the space program also. For more information, contact:

David R. Jones, Jr.
Information Officer, VA Tech L-5
P.O. Box 224
Boones Mill, VA 24065

Is Anybody Out There?

Elissa Wynn, co-chairperson of the Niagara Frontier L-5 Chapter, writes to remind members that if they have indicated that they want to be active locally, they will be included in the computer print-outs from the Society headquarters. If you want to be active but haven't let headquarters know, you risk being left out. Elissa comments, "There *must* be more of us in New York!"

Future Party '79

L-5 has been give a free suite at Future Party '79, a science fact/fiction convention to be held this Thanksgiving (Thursday Nov. 22 - Sunday Nov. 25, 1979) in Albany N.Y. Speakers will include L-5 board member Barbara Marx Hubbard, as well as Isaac Asimov, Jesco von Puttkamer (NASA), Hal Clement, Jacqueline Lichtenberg, Theodore Sturgeon and others.

The theme of our suite will be "Be a Space Activist." As well as an excellent chance to increase exposure of L-5 concepts and recruit members, it can also be a mini-con of Northeast groups. We will share ideas and experiences, catalogue regional resources and hopefully encourage the formation of new groups. Special emphasis will be on producing slide and other programs and displays, so if you have one to share, let us know and we will schedule it and list it on the con program. Anyone with experience in graphics and media would be most welcome to hold a workshop.

Attendance is limited to 700, so plan early. For more information and registration forms contact:

Niagara Frontier L-5 Society
40 Kings Trail
Williamsville, N.Y. 14221

Space Mapping/ Exploration Society

A new chapter of the L-5 Society, the Space Mapping/Exploration Society, has been formed in Sparta, Wisconsin. The next meeting is scheduled for Friday, September 7. For further information, contact the chapter president Dr. Wilfred E. Beaver, 418 E. Main St., Sparta, WI 54656.

Letters

Obviously we (the L-5 members) have a financial problem if the Legislative Information Service (LIS) is to be continually working with the Society. The $703.00 monthly budget proposed to continue this service is peanuts. If the L-5 Society cannot get its members to donate at least 150% of this monthly figure, then we should all look at ourselves as phonies, who may be part of an organization we really don't care about. All members should be asked to donate (tax-deductible or not) a grand total of $2.00 apiece for the remaining year. I am estimating here that the Society is now some 3500 strong. That's $7,000.00 in added donations or $1000.00 a month. No longer can those involved and interested in the successful transition to life in outer space sit back and read about legislation, ideas, and/or advances concerning space without an easy way to voice a respected opinion. Just look at what the government is proposing to do to NASA's budget over the next 5 years, a 1 billion dollar cut! Oh, excuse me, I forgot we need it for national defense, spelled bombs.

Ron DeMartini
San Francisco, CA

I sympathize with Eric Drexler's disappointment that the U.S. government "decided to develop a 'civilian' booster for purely symbolic reasons" instead of using "existing ICBM booster" (**L-5** "The Useful Pieces of Space," **L-5 News**, May, 1979). But I feel that Eisenhower's decision was for the best because it firmly divorced our space exploration from our military. While the decision cost us time, money, and prestige, it showed the world (and our own citizens) that our space efforts were not militarism in disguise. The Soviets do use the same boosters for ICBMs and space activity, and the world knows that their space program is controlled by their military.

Howard G. Beatman
New London, Conn.

H. Keith Henson's piece on "Space Forts" in the June **L-5 News** was a welcome examination of the very real trends in space weaponry. I have tried to explore the military's utilization of such weaponry in my novels, such as **Millennium**.

It has occurred to me that Solar Power Satellites may well be put into operation much sooner than even L-5 Society members expect, by the military of various nations, to provide the electrical power for satellite laser and/or particle beam weapon systems.

While most people tend automatically to reject the very idea of space warfare, out of esthetic or moral reasons, it is important to realize that the military purposes—not civil or humanitarian ideals—may very well be the spur to the development of SPS.

Ben Bova, Editor
Omni
New York, NY

The letter from James Oberg in your June, 1979 issue contains major factual errors which must be corrected. Jeff Phillips is no longer on our (SANE) staff, so I will try to answer on his behalf.

The argument in favor of a larger U.S. anti-satellite program rests on the assumption that the Soviet Union is rapidly building up its forces—that there is an "ASAT gap." Mr. Oberg, quoting from the **Air University Review**, contends that "predictions of the Soviet strategic forces were below the numbers that turned out to be actually deployed." In fact, the reverse is the case. We were told, for example, about the "missile gap" in 1959 and 1960 at a time when the Soviet Union had only a handful of intercontinental missiles and could not have possibly threatened American security. And today we are being told that Russia has achieved "strategic nuclear superiority" at a time when the United States has nearly 10,000 strategic warheads aimed at Russia's heartland. It's time we realize that there can be no gap or advantage to either side when each possesses the ability to obliterate the other many times over.

Both the United States and the Soviet Union are rushing insanely to load their satellites and space vehicles with military capability. The process is absurd, and extremely dangerous to the entire world. Rather than complaining about alleged Soviet advantage in this race, the L-5 Society should join with SANE and other public interest groups to halt this deadly competition and demand the peaceful use of outer space.

There is only one issue in the war in space controversy: the military use of space must be stopped.

David Coprtright
Executive Director, SANE
Washington, D.C.

You will be pleased to learn that, according to a news article in **Science** 4 May 1979 p. 484–486, the arch enemy of creative science William Proxmire (D-Wis) caused the U.S. Senate office building to have installed "magnetic" rodent repellers. Such units may have cost (us) $1195. each. The Senate building repellers were removed after the Environmental Protection Agency reported the results of 1½ years of tests to yield absolutely no results. The "repellers" were not effective at all, and produced no measureable effect on rats or instruments. The article does not say if the $1195 version was the one used in the Senate building, but the value of the parts in this "Nature Shield" model was $20, and the various differently manufactured versions are probably about the same in effectiveness and price.

Surely the honorable Proxmire gets the Golden Sheep award for this one!

John H. Mauldin
Canyon, Texas

I am a charter member of L-5 and a true believer in our future in space. With that established, I wish to say a few words in defense of Sen. Proxmire.

Sen. Proxmire does not oppose space exploration. Sen. Proxmire has said that he would support Satellite Solar Power Stations if the need and feasibility of such a project can be established.

Sen. Proxmire is very leery of any large project involving the U.S. Government and large corporations. Graft, boondoggles, blunders, and outrageous misrepresentation often are rife on such projects and Sen. Proxmire is not at all out-of-line for thinking that such could occur on a project of such magnitude as SSPS.

As long as space colonization is romanticized by it supporters, new supporters will be hard to find. The taxpayers will not approve of a program to spend hundreds of billions of dollars to provide an idyllic life for a few thousand people. Sen. Proxmire and other legislators recognize this.

To get the public to believe in space colonization, we have to show evidence of cost-effectiveness: the public is absolutely right in demanding a return on their investment. Sen. Proxmire is doing his job by watching such proposals closely.

If we can demonstrate solid merit in our program, Sen. Proxmire could be a valuable ally.

Charles S. Upp
La Quinta, CA

I am interested in correspondence with other L-5 members on space colonization. I have an idea for the Society that I got from another club that I joined. Why don't we print a small booklet of names and addresses of members interested in correspondence? This would greatly increase communication among members and would help to generate new ideas. It would also help local chapters.

Ted Apelt
3010 NW 36 St. Lt. A135
Miami, FL 33142

You can receive a list of people in your area who wish to be locally active at no charge from the L-5 Society—CH

Would the **L-5 News** be interested in doing some different kinds of membership surveys with me? What I have in mind is a loose or tear-out questionnaire in the **News** that could be folded and mailed, with the postage printed on it. I have two in mind: One as a sort of fluid shift simulation for the readers to peform and report on. Another, more detailed, would be a food opinion survey for prospective habitat colonists. Sample question: Since maximum efficiency dictates a closed loop life support system, how do you feel about recycling colonists into fertilizer when they die?

Absolutely unacceptable_____
Would rather not_____
Don't care, but not me_____
No big deal either way_____
Preferable_____
It's the only logical thing to do_____

By the way, I am a doctoral student in Nutrition at Florida State University, and I, too, look forward to the day when I can look back on the planet from a distance.

Karl E. Simanonok
Tallahassee, Florida

How about it readers? Would you like to see surveys like the above in the L-5 News? —JA

As it is usually suggested that a colony at L-5 would be an international community, and as the major stumbling block to building a colony is funding, I have a recommendation that may bring us a bit closer to both goals. At present, all the Astronauts and Mission Specialists for the Shuttle flights are either American or European. What if N.A.S.A. were to begin training Mission Specialists from Saudi Arabia and other OPEC nations? Not only would it strengthen American ties with these important oil exporting nations, but their interest in the Manned Space Program could lead to part of the funding necessary to make space colonization a reality.

William N. Ellis
Huron, Ohio

I am sorry to report that ISI is not selling stock in Michigan and that I could not obtain a prospectus from Mr. Basler. Perhaps you should print a list of the states where ISI is legally selling stock. I feel that now is the time to press SPS since we should be able to capitalize on oil decontrol and Three-Mile Island.

Michael Strong
Swartz Creek, MI

Washington State, OR, CA, AZ, TX, Wash DC, MD, NJ, NY, MA.

L5 NEWS

SEPTEMBER 1979

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 4 NUMBER 9 SEPTEMBER 1979

In this issue:

1 **Robert C. Truax: Crackpot or Pioneer?** *by Carolyn Henson. A look at the man behind the "Volksrocket" X-3 shuttle.*

2 **First Private Enterprise Astronaut Selected** *by Carolyn Henson. Daniel Correa will pay $100,000 to face the risks in Robert Truax's X-3 shuttle.*

3 **Technology and the Humanization of Space** *Ed Bas wonders how to make technology exciting to a nation that worships heroes.*

4 **Clearing the Way for Innovation** *by Ken McCormick. Government policies should be designed to stimulate technological innovation.*

5 **Space Day** *A special look at the celebrations of July 20, from national events to our local L-5 chapter happenings.*

Looking Back on Apollo 11 *by Jim Loudon*

7 **Apollo 11 Reunion** *by Jody Rawley*

8 **The Big Event** *by Marcia Allen*

9 **Spacefair '79 — The Impossible Dream Realized** *by Rosemary Shields*

10 **Space Day Picnic, Texas Style**

Space Futures Society Celebrates Space Day *by Chuck Divine*

12 **The Truth About the Skylab Crew "Revolt"** *B.J. Bluth comments on Henry S.F. Cooper's conclusions in his* **A House in Space**.

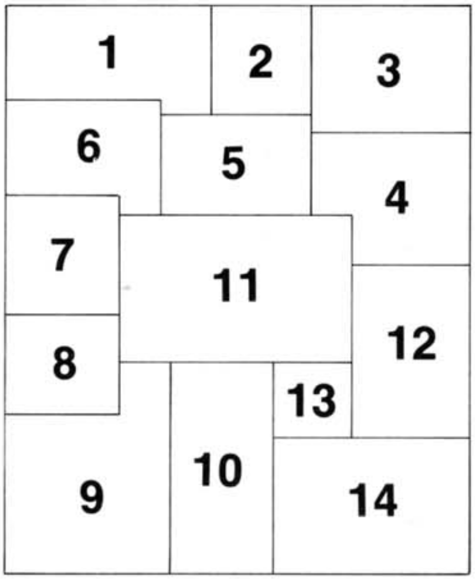
15 **News Briefs**

16 **Space Shuttle Update**

17 **Announcements**

Letters

Cover: The L-5 Society celebrates Space Day! (See articles beginning on p.5.)



(1) Displays by the Boston L-5 (2) Eric Drexler, New England L-5 (3) Chris Peterson, New England L-5 (4) Al Ladne (behind the booth), Boston L-5 (5) Rosemary Shields, Boston L-5 (6) Mike Stopa, a speaker for the New England L-5 (7) Professor John Lewis, a speaker for the New England L-5 (8) Kathy Scribner, New England L-5 (9) Wayne Jefferson and Kathy Scribner of the New England L-5 with Frank Kendig, editor of **Omni** (10) Charlie Lurio, New England L-5 (11) The Space Futures Society's ice cream cake (photo by Charles Divine) (12) Boston L-5 displays (13) The sign outside of Burlington Mall (14) Bill Rudow (left) and Rick Shields of the Boston L-5.

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Robert C. Truax: Crackpot or Pioneer?

By Carolyn Henson

Some people, in response to Bob Truax's novel (i.e., cheap and privately financed) astronaut program, have written him off as a nut. After all, what "professional" would plaster his rocket with ads or, in this post-Nader culture, let his astronauts face a several percent probability of death?

Truax graduated from Annapolis in 1939. By 1942 he was given charge of the Navy jet propulsion project. Later, through the Naval Research Laboratory, he developed the Navy's rocket capability.

Truax, as head of the American Rocket Society (now known as the American Institute of Aeronautics and Astronautics, the professional organization of aerospace engineers) generated a recommendation in 1957 to U.S. President Eisenhower to develop a strong non-military space program. Eisenhower agreed and created NASA.

In 1960 Truax became head of advanced development for Aerojet Engineering Corp. While there he pushed for ocean recovery of reusable rockets — a concept finally adopted for the space shuttle's solid fuel engines.

In 1974 he convinced stunt artist Evel **Knievel to try to jump the Snake River in the rocket-powered "Sky-Cycle." Either the** mission abort parachute opened by itself, or Evel chickened out—who can say? But Truax's Sky-Cycle flew just fine.

Truax certainly doesn't fit in the grey NASA/aerospace mold. But, whatever the fate of his X-3 Shuttle program, Bob Truax already has a solid place in the annals of the evolution of the space age.

First Private Enterprise Astronaut Selected

By Carolyn Henson

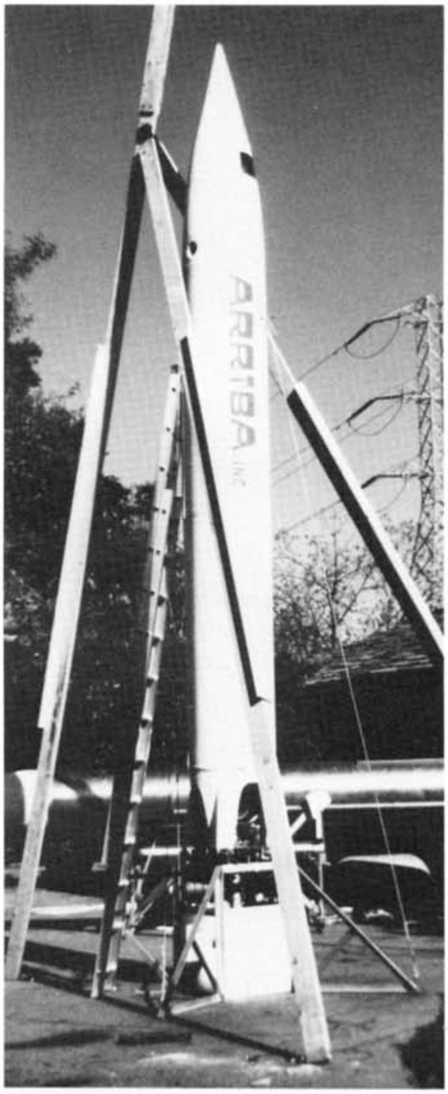
Daniel Correa, a pilot and skydiver, has agreed to finance $100,000 of the costs of his planned launch as the first private astronaut. Correa will make a more than 80-km-high suborbital flight in the X-3 shuttle, a vehicle designed by rocket pioneer Robert Truax.

The X-3 is vertically launched. A centrally located hold-back restrains the rocket until full thrust is reached. At liftoff the thrust-to-weight ratio is 1:3. Burnout occurs at 34,442 m after 60 seconds of powered flight, at which point maximum velocity of approximately 1000 m/sec has been reached.

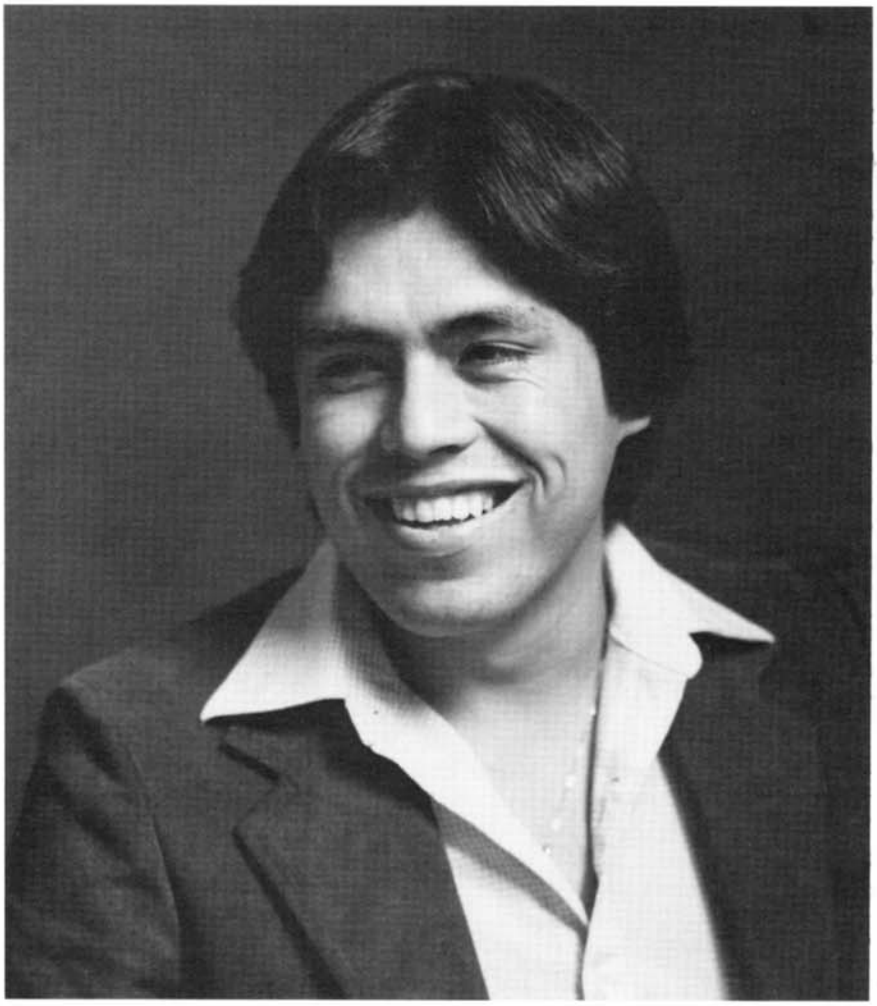
The X-3 coasts to apogee, then falls back to Earth. Upon reaching a descent speed of 1000 m/sec and an altitude of between 30,480 m and 45,720 m, a drogue chute opens to stabilize the rocket tail down and slow it to 45 m/sec velocity.

At 6,100 m the main canopy will open, slowing the X-3 to 20 m/sec at splashdown in the ocean. The spacecraft and astronaut will be located by the combination of an AN/MPQ-10 radar tracking system and an on-board transponder. A 38 m cutter with a helicopter platform on the stern will be stationed in the landing area. A helicopter will rendezvous with the spacecraft using radar and transponder data. Visual contact will be aided by dye released into the surrounding water by X-3.

Two frogmen will attach a hoist to the rocket, which will be lifted by the helicopter for transportation with the astronaut still inside back to the launch area. There he will finally emerge.



Truax's rocket showing the name of one of its commercial sponsors.



Daniel Correa, the astronaut for the Volksrocket.

How will the astronaut stay alive during this hop? Oxygen and compressed air bottles will replenish the air supply. However, X-3 designer Truax admits that his astronauts will face greater risks than those working for the U.S. Government.

The overall project cost is estimated at $875,725. Daniel Correa has no firm launch date as not all the needed funding has been raised. However, tests and construction are already underway.

If the X-3 "Volksrocket" is successful, it will represent a major cost breakthrough and vindicate Robert Truax's assertion that the key to inexpensive space flight is held by private enterprise.

For more information, write: Truax Engineering, Inc., 12401 Green Meadow Lane, Saratoga, CA 95070.

Technology and the Humanization of Space

by Ed Bas

There was a lot of celebrating, a lot of recognition and remembrance the week of July 16-24. In Michigan, it was proclaimed Space Exploration Week in honor of the first footprints on the Moon. Speeches were made and special programs planned at universities, space museums, etc.

But is the excitement over? Technology itself isn't exciting. Neil and Buzz will forever be remembered, but can the same be said for the hardware? And while people will whistle appreciatively as the space shuttle rolls by, don't expect everyone to yell "Spend! Spend!" to their Congresspeople over it. The American public needs heroes, not idols—and humanization of space, not just industrialization.

Technology itself isn't exciting. Neil and Buzz will forever be remembered, but can the same be said for the hardware?

Example: according to an article in the **Journal of Contemporary Business**, we are now in an information phase of space technology. From the 1960s to the 1990s, the space program has centered around Intelsats, Domsats, Tiros, Geos, Landsat, Seasat, etc. Disposable chemical rockets were used as launch vehicles, for a total cost of around $75 billion (1975-adjusted).

The reaction of the American public has been an unappreciative yawn. And a 1976 study by Chase Econometric Associates says this shouldn't be. "NASA R&D spending increases the rate of technological change, improves productivity, reduces the rate of inflation and expands employment." Yet how many people think of productivity when you mention the space program? It means nothing without that necessary humanization.

The Chase study went on to estimate that a $1 billion increase in NASA spending raises the Gross National Product some $2.1 billion the first year and $2.5 billion the second year—a common "multiplier" effect which eventually translates into "lower prices, higher levels of unemployment and greater real income."

In short, money is spent on Earth, not in space. And it's spent on people.

This is known as "macroeconomic impact" in that spending spans some 33 fields from chemical to electrical engineering. Shuttle spending goes to high-technology industries (as much as 70% anyway) compared to 6% for residential construction and 10% for consumer spending. The same can be said for employment: 68% employed by the shuttle program are in technology-intensive industries, compared to only 5% for the other two programs.

In Sterling Heights, Mich.,a bunch of high-technology Vought Corp. workers are about to hit the pavement looking for new work—the $40 million per year ground-to-ground Lance missile is going out of production. One veteran of the program commented that he wasn't really worried about finding another job, nor was he surprised because it is the nature of his trade to go from one contract to another.

If only he could be put to work on solar satellites instead of waiting for the next "defensive weapon" contract to come along.

Isaac Asimov once remarked that "cost is a false issue" when it comes to space colonization. Which is true, because the charts and graphs on economic return, unemployment rates and labor productivity mean nothing, unless you suspected them all along. Or unless you put it all in understandable terms. But then, NASA has never been well-known for its eloquent and colorful language.

In 1978, I listened while a Michigan farmer told me the procedures for applying for federal disaster relief for his drought-devastated corn crop. It was nothing new to him. He'd gone through it before to save his $150,000 harvester/combine—one without the air-conditioning or stereo you see in the Life magazine pictorials. NASA couldn't help him that year, and maybe it never will.

But in 1970-71, the dramatic if obscure "Corn Blight Watch Committee" was formed by NASA and cooperating universities. Some 210 selected corn fields in seven states were given flybys at 60,000 feet with remote sensing equipment. If the corn blight of 1970 were to strike in '71, it could be detected early and something salvaged with a Paul Revere cry to plant soybeans instead.

The blight didn't materialize so the situation never grew as dramatic as it might have. But if you talked to my farmer friend today about NASA and remote sensing, I'm sure he'd listen. It means more than how the GNP is affected or how many high-technology jobs are saved in a year.

Technology shouldn't have to be defended, yet NASA seems to consider it necessary to do so. So much so, in fact, that the term "spin-off technology" sometimes takes on a negative connotation, as though it is an excuse—even a ruse. Technology has to be explained, and explained in human terms that give it meaning.

The Vought workers should be hard at work building powersat components. The Michigan farmer should know what remote sensing does for him. Only then will NASA share some of the "hero" honors with Neil and Buzz.

"NASA research and development spending increases the rate of technological change, improves productivity, reduces the rate of inflation and expands employment."

Will magazine covers a decade from now celebrate the beginnings of space industrialization that took place in 1979? They might. Stranger things have happened. After all, Americans fell in love with the Model T. But that doesn't mean they'll ever lose sight of the American hero. Once NASA connects the high technology with 21st century people, outer space will open up as a new frontier, not as a new factory.

Clearing the Way for Innovation

by Ken McCormick

What's happening to American ingenuity? A new bill could help the government make its policies more favorable towards innovation.

Technological innovation, the key to industrial productivity growth, has clearly been lagging in the United States for more than a decade. There has been a dramatic decline in the formation of new small, high-technology companies which introduce a large share of new products and manufacturing techniques. The proportion of patents issued to American inventors has steadily declined. Productivity gains have ground to a virtual halt, so that the United States now ranks last among the 11 major industrialized nations in the rate of growth.

America's rise to a position of preeminence in the world was fueled by abundant capital, energy and raw material resources, and by cheap labor. All that has now changed, and the U.S. is increasingly dependent on the introduction of new technology to maintain its high standard of living.

The 25 years following World War II saw impressive strides by the United States in the development of nuclear energy, aircraft, computers, space technology, communications technology, and electronics. Other nations, concerned about the "technology gap" between the U.S. and themselves, created special science ministries and intensified governmental support for research. Today, America maintains a clear lead only in space technology, and that lead is slipping rapidly. The industrialized nations are in a race for new technology as they face growing competition from developing countries where labor is cheap and the need for development often overrides concern for social benefits.

President Carter has reversed the decline of governmental support for research, but expenditures remain 16% lower today than a decade ago.

Senator Adlai Stevenson III of Illinois has introduced into Congress the "National Technology Innovation Act of 1979" as a first step towards a determined effort to revive technological innovation in the United States. The bill would create within the Department of Commerce an "Office of Industrial Technology." There are entire departments of the government concerned with natural resources, food, energy and labor, but no agencies with an overall responsibility in technology.

Today, America maintains a clear lead only in space technology, and that lead is slipping rapidly.

The office would provide an ongoing assessment of international and domestic trends, creating a foundation for policy-making in both government and the private sector. The government would use the office's analyses in establishing trade, antitrust and patent policy. Private firms would find the information useful in formulating market strategies and in utilizing innovations of foreign origin.

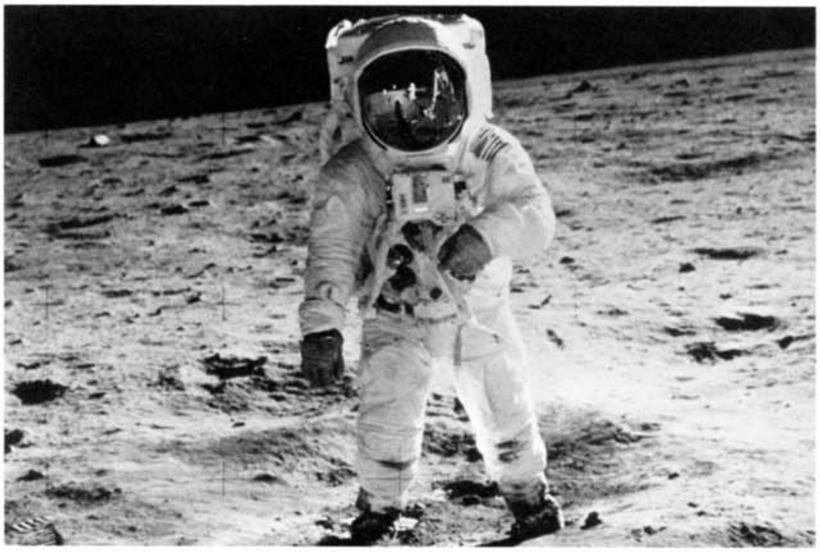
In addition, the office would provide assistance for the establishment of university- or nonprofit-affiliated "Centers for Industrial Technology." Such centers would cooperate with industry in generic research which is now undersupported in the U.S. Would-be sponsors are unable to appropriate all of the benefits which arise from such research, but the *total* benefits tend to far outweigh the costs. Support from society as a whole would be in the society's own interest. The cooperation of the centers with industry would facilitate a better flow of technological information from universities to industry. The centers would also provide education and training in entrepreneurship and technology innovation.

Leaders in the field of research praised the bill in hearings on June 21 and 27, but emphasized that this bill represents only one of the steps which must be taken. A complex set of political, economic, social, institutional, and even religious factors were blamed for the creation of a business environment in which entrepreneurship is discouraged.

Dr. David L. Morrison, director of the Illinois Institute of Technology Research, complained that our foreign competitors do not have to contend with interference from "environmentalists, anti-progress groups, and government regulations, "but instead are stimulated by favorable treatment on taxes, investments, and antitrust regulations.

Witnesses agreed that the United States cannot simply emulate the foreign institutions which have been so successful, but will have to develop arrangements suited to its own social structure. Tax and regulatory policies were identified as areas in which great changes would have to be made if the purpose of the bill was to be achieved, for while the bill provides for the creation of new inventions, it still does not provide an atmosphere in which those inventions may be developed into marketable products. Without that favorable business climate, the government would simply be financing innovations which would be developed and exploited abroad.

Space Day



Looking Back on Apollo 11

By Jim Loudon
Reprinted from **Michigan Space Log**, *July 6, 1979 issue*

Friday, July 20, 1979, 10:56 p.m.: the tenth anniversary of the first human step onto the Moon (or, for that matter, any object other than Earth) by the left foot of Apollo 11 Commander Neil Armstrong. Lunar "soil" (actually rock ground fine by billions of years of meteorite impacts, large and small) is tricky to walk in; the upper fraction of an inch is loose and slippery, while the material below is too firmly packed to provide much support. The overall feeling is like walking in freshly-plowed Earth soil except that the lunar material is more slippery. Your feet sink in about an inch. This is a measure of how much less geologically active the Moon is than the Earth—the Moon is not "dead," as it's so often oversimplified, but it's much less active. A typical inch-deep astronaut footprint should remain visible for 20 million years. What finally destroys it after this length of time—immense by the standards of everyday living but short by geologic time scales—is bombardment by small meteorite impacts.

The scientific findings of Apollo came mostly from the later flights; Apollo 11 was devoted largely to engineering (find out *how* to land on another world, a thing that had never been done before, and get back to Earth before your inevitable errors had accumulated to a fatal level). Science had to take second priority on this first attempt. Where science really came in was on the last three missions (by which time the media had largely lost interest and, tragically, on the three missions that should have come after them but were cut to "save money." Each Apollo flight brought back about as much information as the *sum* of all its predecessors, so the deletion of Apollos 18 through 20 cut the data return to 1/8 of what it could have been...in order to save 5% of the budget. This is known as "cost-effectiveness" in the trade. Nevertheless, although Apollo 11 (for all its symbolic significance) was the least important mission scientifically, the mere fact that it was the first guaranteed that it would make some major discoveries. Here are a few:

The dark areas which make up the "face" on the Man in the Moon (i.e. the maria—rhymes with "aria"—as opposed to the highlands, or brighter areas that comprise the rest of the lunar surface) are gigantic lava flows of the rock called basalt (accent second syllable: ba-SALT). In fairness, that was already known from the unpiloted spacecraft Surveyor 5 which had landed not far from the Apollo 11 site less than two years earlier. It means that the Moon (to the surprise of many geophysicists) is differentiated; that is, during or soon after its formation, the entire globe melted. Its heaviest substances fell to the bottom and the lightest ones floated to the top, forming the lunar crust when the Moon solidified.

What Apollo 11 added to this was that Moon basalts (that's those rocks you watched the Apollo 11 crew pick up—samples of the particular set of lava flows called Mare Tranquillitatis) are similar to those on Earth but not identical—their trace-element composition is different. By "trace elements" I mean the tiny percentages of contaminants, such as gold or lead or europium, that occur in any rock along with the major substances it's composed of. Substances of this sort with low boiling points are less abundant on the Moon than on Earth (e.g. there's very little gold there). Trace substances with high boiling points are more abundant on the Moon than on Earth. Lunar basalts, especially those around the Apollo 11 site, are so rich in titanium that any Apollo 11 rock is a commercial grade of titanium ore by present-day Earth standards—a fact that will be very important as humanity begins to use space resources more and more in the decades and centuries to come.

There's *no* water in the lunar rocks in any form—not liquid, solid, or even water of hydration (water chemically combined with atoms in the minerals that make up the rocks). Yet in the Universe as a whole, water is the single most common chemical compound. The Moon, or the material which was to become the Moon, was evidently intensely heated sometime during or just after its formation. This process drove off all the water and much of the other substances with relatively low boiling points.

The dark areas on the Moon are basalt, a rock that is common on Earth, Mars, Mercury, and probably Venus. The brighter areas that make up the rest of the Moon's surface are a rock that is rare on Earth: anorthosite (an-ORTH-o-site). This finding was a shock. We think now that the anorthosite formed during the time when the Moon melted and differentiated; it consists of the very lightest materials in the Moon which floated to the top and formed a scum. That may mean that the Earth's original crust was anorthosite too—rather than the granite which makes up today's continents, out of which we dig our minerals, and whose origin has been a major geologic puzzle for over a century.

Apollo 11 Moon rocks.

The Moon's craters have not been forming steadily through geologic time; instead, nearly all of them formed during a period of intense meteorite bombardment that was over by the time the Solar System was one billion years old. It is now 4.6 billion years old, so for more than 3-1/2 billion years, the meteorite activity has been relatively low. But *before* that . . . well, the entire surface of the Moon—except where buried by mare lava—is covered by overlapping craters 50 miles across or bigger. Each one formed in an explosion equal to two billion Hiroshima atom bombs. There is no spot on the Moon that has not undergone at least one such explosion.

The "soil" of the Moon is simply smaller rocks; unlike Earth soils, its particles are little modified by processes that occur after they form. This is one of the biggest gifts that nature has given us towards an understanding of the Moon. It means that each crew of astronauts brought back not just a few dozen rocks but tens of thousands of "rocks". Most of them were under 1/100 inch in size, but they could be studied as well as if they were ten-ton boulders. Even the rarest rock types at any given landing site would be represented in such a huge collection.

A brand-new kind of rock, never seen on Earth, neither igneous, sedimentary, nor metamorphic (the three classifications into which all Earth rocks can be placed) occurs on the Moon and was discovered by Apollo 11: "soil breccias" or microbreccias (breccia rhymes with getcha). These are "soil" particles welded together by meteorite impacts.

Natural glass, also produced by meteorite impacts, is a major constituent of the lunar soil. We've never seen such glass on Earth. It determines the appearance of any given spot on the Moon, and it is what welds together the soil breccias. A large fraction of the soil is microscopic perfect spheres of glass, apparently droplets of rock melted by impacts, that froze while in flight after being splashed out of newly formed craters.

The economic effects of Apollo were profound, according to easily available yet virtually unpublicized studies by economists on the effects of space spending. Apollo was never as expensive as was believed by most of the public (our current yearly spending on discotheques averages 2-1/2 times what we spent in a year on Apollo) but the returns were immense. Spinoff alone (new technology resulting as an accidental by-product of space engineering) returns to the economy $14 for every $1 we spend on space or more than a third of a trillion dollars for the $25 billion total Apollo cost. A third of a trillion dollar bills, piled up, would reach 1/10 of the way to the Moon!

Apollo 11 Reunion

by Jody Rawley

On Friday, July 20, 1979 the crew of Apollo 11 was reunited in Washington D.C. The astronauts met at the Smithsonian's new Air and Space building, climaxing the festivities which included special exhibits and video-taped replays of the first lunar landing. The museum's televisions brought the original Apollo transmission to visitors. The ladder descent and first step were at 10:56.20 p.m., exactly when it happened 10 years ago.

Neil Armstrong, Buzz Aldrin, and Michael Collins held a morning press conference in front of the Smithsonian's Apollo 11 lunar landing display, then posed for pictures in front of their Columbia command module. At 11:15, they each spoke in a public ceremony at the museum's mall entrance. At the press conference Neil Armstrong was asked "Do you and your crew harbor any great faith in a revival of America's interest in space, and do you believe that there will be an L-5 before the year 2,000?" He answered that all three looked forward to a revival of national interest in space with the shuttle program and that he hopes public interest does *not* reach the enthusiastic heights it did for Apollo 11. Armstrong explained that exploration should mature into a "respectable, professional, and routine," endeavor, and not be a spectacular oddity. He then said that "perhaps a smaller scientific research space station might have more immediate advantages, but an L-5 definitely should be looked into."

One NASA official cited this National Space Exploration Day as "beginning an era, the era when America moves from one Columbia to another Columbia," referring first to the Apollo 11 command module and then to the first Shuttle slated for launch and orbit. The crew of the Shuttle Columbia, John Young and Robert Crippen, also attended the outdoor ceremony and presented Neil Armstrong with a model of their spacecraft.

Below: Armstrong, Aldrin and Collins (left to right) shake hands in front of the Smithsonian's Apollo 11 display. (Photograph by Charles Divine.)

Right: Neil Armstrong cheerfully conducts a morning press conference, a photo of his 1969 ladder descent behind him. (Photograph courtesy of Jody Rawley.)

Lower right: In the command module Columbia, 1969, Neil Armstrong, Michael Collins and Edwin "Buzz" Aldrin (left to right).

The Big Event

by Marcia Allen

In July, Boston's popular Quincy Market, with its cobblestones and endless modern boutiques, paused in its usual hectic activities to witness a unique event — Space Week '79. Focusing on humanity's efforts to reach out into the universe, Space Week was a celebration of the 10th anniversary of Neil Armstrong's "one small step."

Space Week was also *our* first **Big Event**!

For the week-long celebration we planned a variety of activities. We scheduled about 16 speakers and at least as many films *and* set up a New Space Program information booth as well. The preliminary planning (to find out who would speak on what when); the hectic last minute rush (to find a printer at 11 PM Sunday night) — all this was for us a real *first!* By the 15th we were bug-eyed with excitement, anticipation — and terror. Was it really going to happen?

July 16th came and so did Space Week. Although quite different from our first distant visions, Space Week more than repaid our efforts. Our programs and activities gave us countless opportunities to "get out" and see what people really think of space — and of us. And more than that, it gave us a chance to find out what we could do.

Designing a twenty-hour, three-day program at Faneuil Hall that would appeal to the public was our biggest challenge. We were fortunate to have many fine speakers offer their services without charge and to have more than enough films loaned to us. The challenge, however, was to put it all together. We did one better; we not only had our Faneuil Hall program but had enough to spare to put on two special evening programs at the Boston Public Library.

In doing all this we discovered many new resources that will be valuable to us in future programs. For example, we found speakers to add to our list about whom we knew little or nothing before Space Week. One professor from MIT gave such a good talk on planetary exploration that most of the audience stayed on for almost an hour to talk with him. (You can bet we will schedule him again.) Another resource we discovered was the Boston Public Library — it has a good lecture hall and is free. With this in mind we hope to plan several more programs there for the coming year. Also, we hope to explore other public libraries in the region.

Our most public activity was our information booth at Quincy Market, which we ran for most of Space Week. Our booth was devoted to the New Space Program and was surprisingly easy to put together. We had handouts, books, and L-5 material on display, and our members were around to talk with people.

Marcia Allen getting some sun at the information booth. (No, those aren't moonrocks!)

We not only talked, but did a lot of listening; people seemed to welcome the opportunity to talk to us about space. We had one eight-year-old tell *us* about solar power satellites (SPS). A soft-technologist stopped by and spent an hour praising SPS to another soft-tech. (Although most people were positive about space utilization, we did get some negative comments: one elderly woman stopped, quietly looked over our table, then said "Bullshit!" and stomped away.) It was good to listen to people's comments because we discovered some things. Some people didn't read past the "Solar Power . . ." and told us all about their wood-burning stoves. We also found out that some people were not well informed about the mechanics of space. (It didn't help that Skylab fell the week before.) One man told us quite seriously

Some of the people who made it happen: (left to right) Nancy Mari was the chief sign-maker; Blaine Atkins, the New England L-5 president; Eric Drexler and Chris Peterson put in time at the booth.

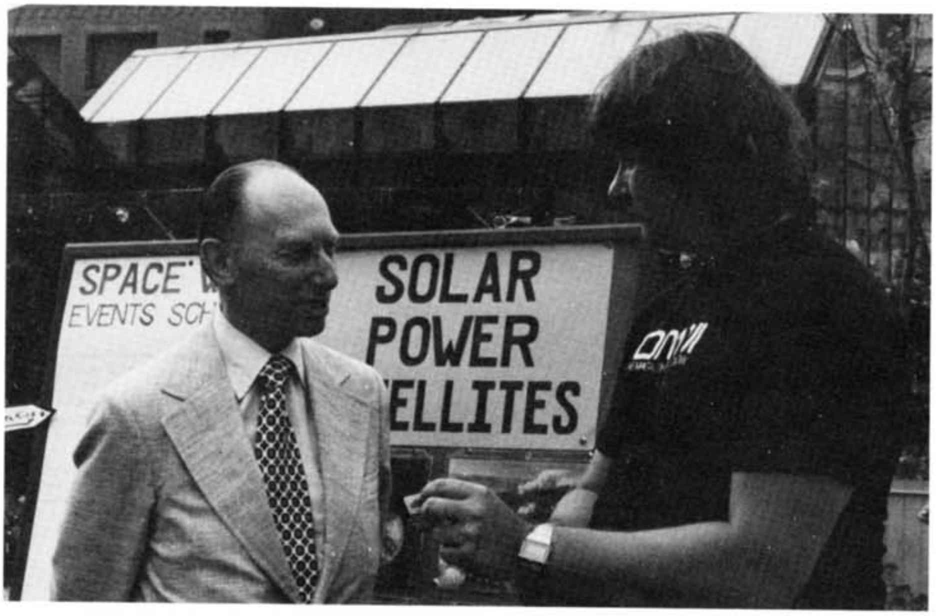
that we couldn't possibly collect so much solar energy because we would drain the Sun's energy, and it would not be able to rise.

One little two-sided sheet of paper provided us with our greatest success in public contact. Our Space Week Questionnaire (almost an afterthought) turned out to be a gold mine! It kept our booth constantly surrounded by people and helped to get people thinking about Space. When they finished the questionnaire, they often stayed to talk with us enthusiastically about space utilization and solar power satellites. The questionnaire also helped us to quantify several things: the number of people stopping at our booth (we had over 400 completed), and the number of people really interested in continuing space development (most people didn't think that national prestige was a good reason to continue space development, but did think that further exploration of the solar system was very important).

But that's not all our little gold mine did. The questionnaire provided us with over a hundred potential recruits—positive people in our area who gave us their names and addresses! What more could you ask for?

By July 22nd we were all feeling a bit smug; we were really pretty pleased with ourselves. After we got everything put away, we sat around and talked authoritatively about how we would do Space Week '80. (One of our members has already formed a Space Week '80 Committee.)

Even now we smile at how good it felt to do that **Big Event!**



Dr. Peter Glaser (left), the inventor of the solar power satellite, was one of the speakers at Faneuil Hall. Here he is with Wayne Jefferson.

Acknowledgements:

The New England L-5 would like to thank all those who helped with Space Week '79. First, thanks to all our members who were instrumental in making Space Week a reality, especially Blaine Atkins, Chris Peterson and Eric Drexler who gave their leadership and management to our program. A special thanks to Wayne Jefferson for generously donating the funds for Faneuil Hall, as well as for his efforts in helping with Space Week. And a personal thanks to Jim Mabry for his help and encouragement.

We thank all those who helped us behind the scenes: loaning us material, getting films, etc. A special thanks to Bill Rudow who did so much behind the scenes.

We thank all those who participated in our programs, and also those who offered to participate.

Further we thank the people at Faneuil Hall, Quincy Market, and the Boston Public Library for all their kindnesses. And, of course, we thank Governor King for declaring July 16-22 Massachusetts Space Week.

Finally, we thank the National L-5 Society for their ongoing support.

Spacefair '79 — The Impossible Dream Realized

by Rosemary Shields

Question: Can a new, eleven-member chapter blanket a big city with space week exhibits in their spare time—and have a marvelous time doing it?

Answer: Yes!

What Was Done

For Spacefair '79 the Boston Chapter focused on exhibits. The sites included the main U.S. Post Office, the Prudential Center (a 50-story downtown office and shopping complex), the John F. Kennedy Federal building, the Boston Public Library, the Tufts University Library, and the Burlington Mall— the largest enclosed mall in the Boston area (500,000 people pass through it each week). After filling the mall with exhibits, we ran a booth and the results were so good that we plan to have booths at *all* locations in the future.

We found the site directors extremely cooperative and interested, and have been invited back again for future exhibits. In fact, the Post Office in Boston asked us to extend the exhibit for a week because of the strong public response.

Results

- Invitations to provide exhibits and programs for a number of civic and private organizations.
- Over 200 seriously interested names for

Rosemary Shields at the booth in Burlington Mall.

our mailing list.

- Over $300 in contributions resulting from just 20 hours of booth sitting (five evenings and two Saturdays).
- Active cooperation with New England L-5, establishing an important precedent for regional cooperation.
- Phenomenally high morale and momentum in the chapter as we discovered how effective we could be and how much fun it was working as a team.

Impressive Points

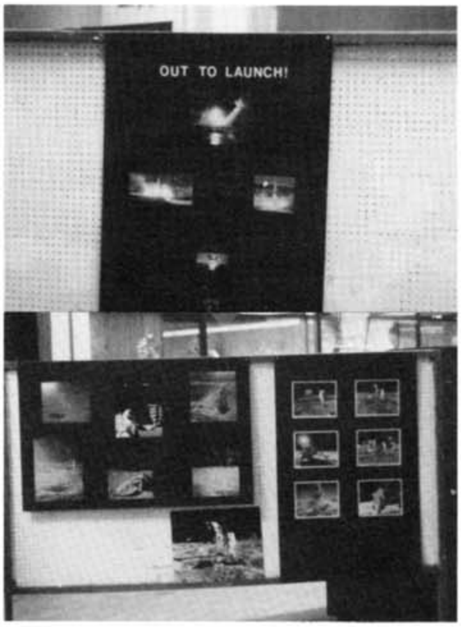
The response of people who came to our booth was overwhelmingly positive, and they were hungry for information. Selling space is easy and exciting. Since we were prepared for hostility, the amount of public support stunned us. We conclude that L-5 can completely reverse the current downhill slide of space support. This may seem a wild extrapolation from 20 hours of booth duty, but you'd have to try it yourself to understand why we feel this way.

The whole enterprise—preparing exhibits, setting them up, running the booth—was exhilarating beyond belief. It is a great way to get a chapter off the ground. Before this project we had a strong committment to space, but little sense of being a team working toward common objectives. Now we are a seasoned, cohesive chapter with enough projects in mind to keep us working for years to come. Not only do we work effectively together, but we have a great time doing it.

Lessons We Learned

- Organizing and planning as a group, with good communications among the members, is essential.

Above: Last minute preparations at 3:00 AM! Left: Rick Shields; right: Bill Rudow. Below: Some of the displays in Burlington Mall.



- Enthusiasm builds exponentially as a chapter becomes immersed in a common project.
- Booths work well from many perspectives, including feedback on public attitudes, fund raising, public relations, and group morale.
- Handouts are critical, and can be used even when no one can staff the booth.

We have prepared a packet on how to do (and how not to do) exhibits. This includes sample letters, layouts, handouts, cost estimating sheets and planning sheets (the time and cost planning sheets were developed *after* having been through space week!). If you would like a copy for your chapter, simply write L-5 Society, Boston Chapter, P.O. Box 162, Prudential Center, Boston, Massachusetts, 02199. Let us know your experiences with using it so we can improve its effectiveness.

Space Day Picnic, Texas Style

Reprinted from **The Colonist,** *the newsletter of the L-5 Society of Texas.*

L-5 Texas held its first annual Space Day Picnic in Clear Lake City on July 22. Among the many things which happened out among the trees was a Frisbee Fight which ended with everyone attacking Bobby, the Boston Barbarian, with all available ammunition. Also, some very irreverent photos were taken of the new L-5 Texas president who found himself unexpectedly sitting in a trash can. Everyone had such a good time that plans are already underway for the highlight event for 1980—the school teacher is going to hang the "Sugarland Kid" (junior) from a tree and perform a lobotomy with a baseball bat. Y'all come!

Space Futures Society Celebrates Space Day!

by Chuck Divine

The Space Futures Society (Philadelphia's L-5 affiliate) celebrated Space Day with a picnic at Pennsylvania's Neshaminy Park. Swimming, frisbee tossing and volleyball were the order of the day as some of our membership met to celebrate past successes in space and plan for future ones. The pièce de resistance of our celebration was an ice cream cake (see cover) decorated with a model of the lunar lander (acquired and assembled by member Donna Varr). Soon after the photograph of the cake was taken, the hungry mob devoured the ice cream cake, leaving it only a delicious memory of a happy time. Gorged and happy, the picnicers departed for their respective homes, vowing to continue to work for space.

The Space Futures Society at their Space Day picnic. (Photo by Charles Divine.)

What do these people have in common?

KRAFFT EHRICKE

CAROLYN HENSON

TOM HEPPENHEIMER

BARBARA HUBBARD

RICHARD JOHNSON

TIMOTHY LEARY

PETER VAJK

...THEY WANT TO LIVE, WORK, AND PLAY...
IN SPACE!

Join Them ...

In a documentary ...

A VOID HOME

-About SPACE INDUSTRIALIZATION AND SETTLEMENT.

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—Curt Bormann, L.A. TIMES

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The Truth About the Skylab Crew "Revolt"

by B.J. Bluth, Ph.D.

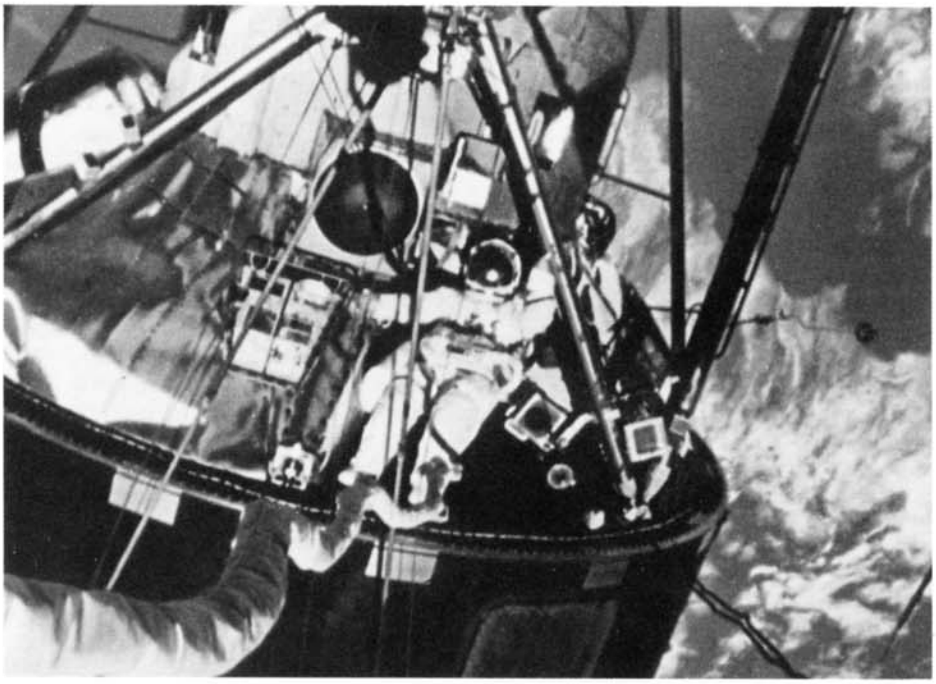
Rebellious Astronauts! How remarkable, and even romantic, to find a revolt at the heart of the NASA Space Program! And it seems Henry S.F. Cooper, Jr., in **A House in Space**, succumbed to the temptation. The record needs to be set straight.

Cooper starts the "Skylab rebellion" theme early, by saying that one of the most important results of the Skylab experiment was that "some of the astronauts would rebel." At the end of the sixth week in space, the third Skylab crew composed of Commander Gerald M. Carr, Science Pilot Edward G. Gibson, and pilot, William R. Pogue, took a day off. This action, according to Cooper, was preceded by days and days of bitching, complaining, grumbling, griping, and impatience about nearly everything in the Skylab. Ground Control, he says,

> wondered whether there was anything in the strange alchemy of space that had changed their characters. They were unaccountably irritable, even when they were getting dressed in the morning. They complained that there weren't enough changes of clothes . . . they bitched that the bundles had been packed too tightly. Then they grumbled that they didn't have a great enough variety of clothes.

. . . Cooper notes men . . . evidencing a "blend of ridicule, exasperation, and plain hostility" that was notably unusual for astronauts.

The "complaints" go on as Cooper notes men "blowing up" over velcro that didn't stick, and pockets that were too small, evidencing a "blend of ridicule, exasperation, and plain hostility" that was notably unusual for astronauts. This "testiness" culminated at the end of the sixth week in what Cooper calls a "memorable bitch" where Carr made a "sort of declaration of independence to the ground" followed by the complete crew taking the whole day off—the revolt.



Shortly before the end of the Skylab mission, Scientist-Astronaut Edward G. Gibson climbed out of the hatchway to begin the crew's final extra-vehicular activity. From above the obscuring atmosphere of the Earth, the astronauts got a unique opportunity to observe Comet Kohoutek.

One thing Cooper fails to mention is M487, the "Habitability Experiment." All the crews went up to the Skylab equipped with an elaborate checklist of some 180 items that they were to evaluate and make descriptive comments about, "especially for items considered only adequate or less than adequate." Not only were they to fill out the checklists, they were also asked to voice-record spontaneous comments when the situation arose as these were considered an "excellent source of data since they would probably be the result of some onboard discovery." The whole point of M487 was to have complete written, audio, and filmed records about the habitability of the design of the crew quarters and work areas in zero gravity conditions so future space stations could be designed more effectively and more comfortably. Many of the comments that Cooper dubs spontaneous "gripes," "grumbling," "complaints," and "bitching," etc. are actually responses to the items on the M487 Checklist, and the third crew members were not the only ones to be critical.

To give you some idea of the extensiveness of the experiment, *some* of the checklist's 180 items are as follows:

- Architecture:
  - Compartment Arrangements
  - Color Scheme
  - Floor Design
  - Light Baffles
  - Windows
- Communications
- Environment:
  - Temperature
  - Noise
  - Humidity
- Food Management:
  - Beverage Dispensers
  - Food Cans
  - Wardroom Table
  - Water Gun
- Garments
  - Comfort/Fit
  - Warmth
  - Don/Doff Ease
- Housekeeping
  - Cleanup Procedures
  - Trash Collection
  - Unanticipated Problems

    - Utensil Wipes
- Locomotion
- Maintenance
- Manual Dexterity
- Mobility/Restraints
    - Equipment Restraints
    - Shoe Cleats
    - Handholds
    - Sleep Restraints
- Off-Duty Activity
- Personal Hygiene
- Tool Inventory

It was the spirit and intent of this experiment to identify and describe as many problems as possible, when they arose, on the assumption that the men would forget many of the details once they returned to Earth.

It is true that Carr, Gibson, and Pogue took a day off, but the term "revolt" is not the only interpretation possible, and with the M487 to defuse much of the supposed "rebellious" attitude of the crew, the picture looks quite different.

The situation *was* one of frustration for the crew. Contradictory commands had been given to the crew before launch and once they were up in Skylab. Carr had been told by William C. Schneider, Director of the Skylab Program, that his crew was to go at a slower pace than the previous two crews. However, Ground Control was busy adding new experiments to the schedule which resulted in putting the crew under a lot of pressure. According to Carr's statement to the ground:

> We'd all kind of hoped before the mission, and everybody got the message, that we did not plan to operate at the second crew's pace . . . We're beginning to get just little hints and indications that we're getting into a time bind—that it's got people really worried down there. People are asking about experiments, and the medics are asking about exercise . . . I imagine you guys are probably caught right smack in the middle of it.

Carr wanted to know where things stood, what needed to be done to catch up, and "What can we do that's reasonable?" He wanted to be in on the conversation. Instead of being labeled a "diatribe" and a "declaration of independence" this stand on Carr's part can be seen as a "hold" until things could be straightened out and the conflicting instructions resolved. Carr himself saw that as Commander, and in a position to directly observe the effects on himself and his crew, it was up to him to call the slow down. Soon after Commander Carr requested that Mission Control work out the contradictions, "the third crew's performance soon improved."

In light of M487 and contradictory work expectations, Cooper's revolt dissolves along with the mist of the "strange alchemy of space," leaving us again to marvel even more at the fact of people's capability for work and survival in space.

B.J. Bluth is an Associate Professor of Sociology at California State University, Northridge, CA 91330. She conducted a symposium on the industrialization and settlement of space June 25th through August 3rd.

A Question of Semantics?

Comments by Henry S.F. Cooper, Jr.

Dr. Bluth is correct in pointing out that many of the astronauts' pithier comments about life and conditions inside Skylab came in response to lists of questions they had to answer for the so-called "Habitability Experiment," M487. Many did not. She is wrong in saying I made no mention of the experiment in **A House in Space**; I describe it on pp. 39 and 40, Bantam edition. Discussing living conditions in space, even at the ground's request, is still a legitimate expression of the astronauts' feelings, and I fail to see how it detracts from the genuineness of the third crew's irritation. I certainly don't see how the M487 "defuses" Commander Gerald M. Carr's words with Mission Control, which preceded the astronauts' taking a day off—especially as he also questions the ground controllers' motives and suggests that some of the extra workload might be caused by "people coming out of the woodwork with new things to be done." No one at the time regarded Carr's words as a fireside chat.

I think Dr. Bluth misunderstands my use of the phrase "strange alchemy of space," which I introduce early in the book (p. 10) only to knock it down later myself. It was appropriate there because at the beginning it was a question in the minds of many people at the Space Center who were baffled and concerned by the irritation of the third crew. I then go on to demonstrate at considerable length how the crew's problems and annoyance in fact are due to overprogramming by the ground and contradictory commands—a situation Dr. Bluth presents as though she just discovered it. The fact that these problems originated on the ground is not a good argument for the astronauts being any less angry at Mission Control. There is always a tendency to play down the intensity of an event afterwards, but I do not think that Dr. Bluth has succeeded in smoothing over this one.

Response of B.J. Bluth

The point to be made about the Third Skylab Crew is that there is no evidence they "revolted." A "revolt" implies a rejection of the legitimate authority. It is a protest which refuses to accept the obligation and duty to obey, and substitutes some other authority—thus a declaration of independence.

To suggest that people trained in, and a part of the military, as Commander Carr and Pilot Pogue were, "revolted" is a serious innuendo, both to the people involved and for those planning future space missions, and such intimations can have many unanticipated consequences.

Thus, it makes a big difference if you imply that the astronauts' "griping" and irritability were all signals that foreboded a climactic revolt, or if you say that (a) a lot of the apparent "griping" was a planned response to the M487, (b) a lot of frustration was in response to impossible and contradictory commands, and (c) Commander Carr exercised his legitimate authority to solve the problem. The event was intense. But was it a revolt? I think not.

P.S. **A House In Space** is *well* worth reading.

The American Heritage Dictionary defines "revolt" not only as "an uprising against state authority" but also as "any act of protest or rejection." Attempts to define the troubles aboard Skylab as revolt or non-revolt might end up as just a question of semantics. — JA

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NEWS BRIEFS

The Salyut-6 space station crew, commander Vladimir Lyakhov and flight engineer Valeriy Ryumin returned to Earth at 15:30 Moscow time Sunday, August 19 after a record-breaking 175 days in orbit.

A TASS special correspondent asked the two cosmonauts, "What were your most memorable moments upon landing?"

"My first impression," replied Lyakhov, "was the odors of the steppe when I opened the hatch."

When the cosmonauts arrived at Baykonur they were handed bouquets of gladiolis. The cosmonauts couldn't hold them long, admitting they felt "heavy as sheaves of wheat." However, Soviet doctors report Lyakhov and Ryumin were in the best condition of any returning cosmonauts. The two walked around and even took a short swim their first day back on Earth.

They didn't sleep well the first night, however, because even the softest bed felt like a rock after months of weightlessness!

July 3 the United Nations Outer Space Committe unanimously reported out an "agreement governing the activities of States on the Moon or other celestial bodies." The General Assembly will vote on it in mid-September. It is expected to pass by a heavy majority.

Although the entire U.S. delegation to the U.N. Space Committee supports the treaty, NASA Ames Chief Counsel J. Henry Glazer opposes the treaty because it regulates trajectories to the Moon as well as the Moon and all other celestial bodies. Glazer supports a lasseiz-faire approach to all shipping of goods and passengers in space. "It's an issue of human rights."

Former chief U.S. negotiator on deep seabed issues Leigh Ratiner warns the treaty will effectively ban private enterprise using extraterrestrial materials. Neil Hosenball, NASA General Counsel, counters that by stretching the treaty's language it will be possible for private companies to operate in space. Retorts Glazer, "There's no such thing as a treaty that doesn't mean what it says!"

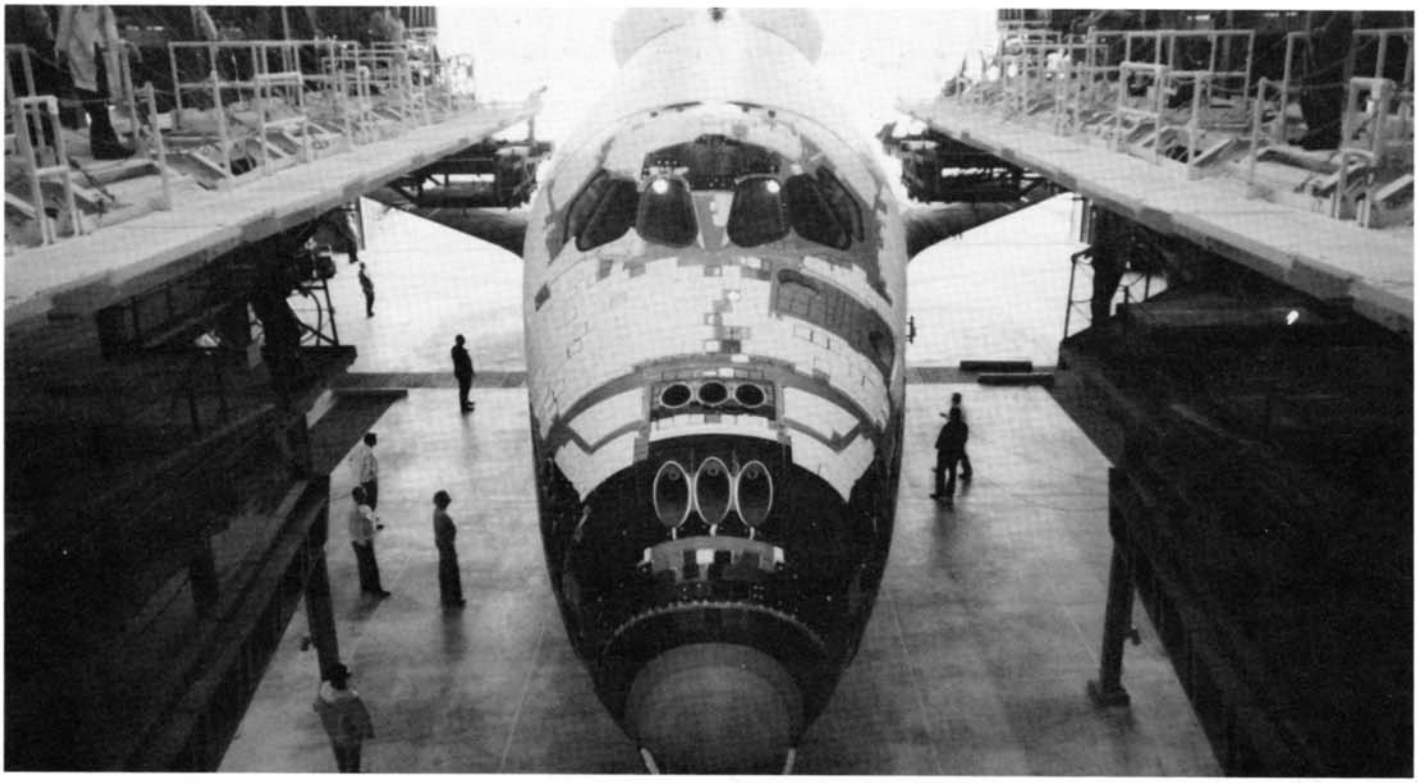
Sept. 10 Dr. Glazer will detail his objections to the new moon treaty at a meeting of the Bay Area L-5 Chapter. For more information call (415) 223-2463.

Congress chopped $1.5 million from the Department of Energy budget for solar power satellites. The final budget is still considerably higher than last year's, however, including $5.5 million for R&D and $0.5 million for equipment purchase.

Russian cosmonauts Lyakhov and Ryumin installed a 10 meter radio telescope on the aft area of their Salyut-6 space station. The antenna was delivered by a Progress 7 transport rocket. It has been used to survey parts of the Milky Way as well as the Sun and Earth.

When used to observe the Earth it returns data on humidity and surface water content. Observers also point out that it should be able to detect the wake of submarines even when deeply submerged, possibly allowing the Soviet military to make a first strike against U.S. subs.

Job opening: Princeton Prof. G. K. O'Neill is looking for someone with a B.S. or M.A. in physics or electrical engineering, recent graduate, with one or two years experience in discrete component electrical circuitry design, to work with Bill Snow on the mass driver project. Send your resume to Laura Hagopian, Dept. of Physics, Jadwin Hall, Box 708, Princeton, NJ 08544.



The space shuttle orbiter Columbia

Space Shuttle Update

NASA has named the remaining four Shuttle Orbiters after oceangoing vessels used in world exploration and discovery. Orbiter 102, scheduled to be launched into Earth orbit late this year or early next is named Columbia. The other orbiters are: 099—Challenger, 103—Discovery, 104—Atlantis. The first orbiter constructed (101) was named Enterprise in 1976 after the flagship in the popular television series "Star Trek."

Columbia arrived at Kennedy Space Center March 24th on top of the 747 shuttle carrier aircraft. Later this year Columbia will be mated with the fuel tanks and made ready for launch.

The Enterprise has completed a nine month long ground vibration testing program at Marshall Space Flight Center in Alabama. All the shuttle elements—the orbiter, external tank and solid rocket boosters were assembled and put through conditions matching those during various phases of actual flight. The tests showed that the Shuttle will withstand the vibration forces it will encounter during powered flight into Earth orbit.

The Enterprise was flown to Kennedy Space Center and assembled with the external tank and solid rocket boosters in the giant Vehicle Assembly Building and moved to the launch pad. This cleared the way for the launch of its sister ship, the Columbia, by making certain the shuttle elements are compatible with the spaceport's assembly and launch facilities and ground support equipment and by providing for training of space center personnel.

Two early-configuration Spacelab pallets have been delivered to the Kennedy Space Center. One of the pallets will be used on the Space Transportation System (STS)-2 mission and the other is tentatively planned for STS-9. Delivery of the Spacelab module is planned for April 1980.

NASA is currently working toward a launch opportunity between March and June of 1980. No exact launch date has been named. NASA is currently assessing manufacturing and testing progress in an attempt to refine a launch date.

"We are at a fork in the road. One sign post says: Surface—cutback, stagnate, leave whatever space activity there is to the military. The other says: Space—explore, develop, stimulate, industrialize."—Hugh Downs, president, National Space Institute.

Our thanks to Robert Dotson for contributing information and locating photographs.

New Shuttle Patch—*The official insignia for the first Space Shuttle orbital flight test was recently issued. Crewmen for the Columbia (orbiter 102) will be Astronauts John W. Young (commander) and Robert L. Crippen (pilot).*

Announcements:

Errata

We would like to apologize to Theo Pirard for neglecting to credit his contribution of the photograph of the Guyana Space Center in the June **L-5 News.** The photograph appeared in the article entitled "Ariane Ahead of Schedule" by Randy Clamons. The map serving as background for the photo, also not credited, was courtesy of ESA.

Habitat 2000 - Dimensions in Space

This is the title of a new adult education class to be presented at the Buffalo Museum of Science in cooperation with the Niagara Frontier L-5 Chapter.

The purpose of the class is a striving to understand human activities in space. Who were the people who struggled to turn the dreams into reality? What were the critical events and decisions that shaped the course of the struggle? What is happening today—from planetary exploration, Landsat and the Earth resources programs to Shuttle and Spacelab? In what direction will we go tomorrow—to solar power satellites, large space habitats, mining of the Moon and asteroids and manufacturing in space?

The class will use lectures, films, slide programs and discussions to explore this complex field. It will closely examine the structure of the U.S. and international space programs, look behind the headlines at the politics of space and at such topics as space law, the militarization of space and the role of free enterprise.

The text will be "The High Frontier" by Dr. Gerard K. O'Neill. Teaching the class will be Elissa Sisti Wynn, Michael Cooper and Jim Conyngham.

Elissa Sisti Wynn has been a space enthusiast since Sputnik. A member of the L-5 Society and National Space Institute, she is founder and present co-chairman of the Niagara Frontier L-5 Society, a museum affiliate club.

Michael Cooper has a bachelors degree in aerospace engineering and a masters in engineering science. He is an engineer at Bell Aerospace, a member of the American Institute of Aeronautics and Astronautics and co-chairman of the Niagara Frontier L-5 Society.

Jim Conyngham is a computer scientist at Calspan, a local aerospace firm. He is an officer of the Niagara Frontier L-5 Society, a member of the Institute of Electrical and Electronic Engineers and active in the Association for Computing Machinery.

The class will be held on Wednesday evenings, 7:30-9:30 PM from September 12 through November 7, 1979 (nine sessions). For more information on the class or for L-5 members wishing to start a similar class in their area, contact: The Niagara Frontier L-5, c/o Elissa Wynn, 40 Kings Trail, Williamsville, NY 14221.

Innovative Concepts Sought for Solar Cells

DOE has begun a research program to find new methods of converting the Sun's energy into electricity using photovoltaic, or "solar" cells.

The program, termed the Innovative Concepts Program, will be coordinated by the Department's Solar Energy Research Institute in Golden, Colo. To participate in the program, researchers are being asked to submit "letters of interest" to SERI by February 15, 1979.

Present plans call for similar solicitations twice yearly. With a major goal of developing low-cost photovoltaics, the research and development areas include new high-risk photovoltaic conversion concepts; cell structures and geometrics; materials; junction formation techniques; fabrication processes; and material deposition methods.

The primary targets of the program include universities, small businesses and private investors. many of whom often find it difficult to obtain funding for their high-risk ideas. Initial contracts are expected to be for one year. Those projects that demonstrate sufficient potential will be considered for renewal or incorporation into previously established activities in DOE's photovoltaic program.

Requests for further information and the solicitation document should be submitted in writing to: Solar Energy Research Institute, Attn: Roger Ganger, Contracts Branch, 1536 Cole Boulevard, Golden, CO., 80401

Rooftop "Earth Stations" Wanted

A group of amateur astronomers at and around Rensselaer Polytechnic Institute of Troy, NY, is currently designing a 12" dia. Amateur Space Telescope for release into orbit by the space shuttle. We are interested in corresponding with people who own, or plan to build, rooftop "Earth stations" that are capable of receiving pictures from weather satellites. Stations in the southern US and in foreign countries would be of particular interest.

We are also interested in corresponding with others who plan to use the Space Transportation System and who might be interested in forming an organization for non-professional builders of Gateway special experiments, satellites, Earth stations, etc.

Please address letters to: Jesse Eichenlaub, 100 9th Street, Troy, NY 12180.

Letters

There is another method of using space solar electric power that many of us may not have considered. Although as members of the L-5 Society we fervently believe in the concept of space solar power and the SPS, many people in this country feel that the concept is a little (if you will excuse the pun) far out. Many of these people would, however, be much more accepting of ground-based, conventional, solar-fired power plants. These plants have an obvious drawback in that the Sun does not shine at night; even so, there will probably be experimental plants built in the near future.

However, we can help this problem associated with ground-based solar energy; we can make the Sun shine at night, too. If two or more large mirrors are orbited in geosynchronous orbit, sunlight could be reflected to one or more existing ground-based solar power plants. This would provide for the illumination of the plants at night and thus continuous power generation (eliminating the need of expensive and inefficient power storage methods). This idea has a number of points in its favor: (1) mirrors can be put in orbit much more cheaply than, say, solar cells (assuming all materials upshipped from Earth—they simply weigh less), (2) the beam is sunlight at approximately one sun in intensity (no significant environmental damage is likely to occur from sunlight at an intensity of one sun), (3) the beam could not be considered a weapon by any nation, (4) the power generation system is less subject to military attack (the power generating station is not at the mirror and could still function during the day without the mirror—also mirrors are less subject to damage than fragile microwave generators or laser tubes), (5) and last but not least, this system provides for a phased buildup to the SPS.

The value of a phased buildup in such a project as the SPS concept is obvious, if one looks at it from the standpoint of the taxpayer. (What would the average taxpayer say if you asked him for a few hundred billion to build powersats?) However, the cost of expanding *then existing* solar power plants by adding large space mirrors would be small in comparison to the cost of the SPS system, and it would be relatively easy to get the government and NASA to buy it. Then, when people begin to accept the concept of power from space as practical and economical, the idea of the SPS can be put forward as the practical and elegant energy source it is.

Steven D. Hamm
Clear Lake City, Texas

There are several problems of the space mirror for Earth solar power ("solares") concept that are not shared by SPS.

The disk of the Sun is wide and its light incoherent. This means that at geosynchronous altitude the minimum size beam would be enormous. For this reason the solares design calls for low orbit reflectors. But this means only dawn and dusk lighting of power plants—things will be dark as ever in the middle of the night. Low orbit systems also mean the minimum system size will require many mirrors.

Solares will cost less than an SPS system. But it will perform far more poorly. Nevertheless, the cost vs. performance tradeoffs may be sufficiently favorable for solares to become a first step toward space solar power.—CH

Steven Lubar's letter (April **L-5 News**), in which he criticizes the Society for becoming "a cheering section for a couple of big corporations . . . Boeing and Grumman," intrigues me. He is clearly more interested in means than in ends—a variant on the ethical-over-pragmatic position.

What Lubar wants is "to change the future course of technology". Since the two quotes are part of the same sentence, he assumes that "change" will shift "big corporations" out of space industries. While I appreciate the small-is-beautiful sentiment, I do not see a necessary connection between the aforementioned *change* and *shift*. Space exploration and industrialization, no matter what technology is used to carry them out, is a large-scale enterprise which requires large-scale manufacturing (and *high* technology).

While "big corporations" may not in fact be the best way to get into space, a "*big* something" will be the best way and *only* a "big something". It is scale which is important here, not form. Also remember that any decision to shift corporations out of space industries will be made by the government and is thus a political, not technological, decision. (Ignore Karl Marx and Adam Smith: if politicians make a decision, it's a political decision.)

Howard Beatman
New London, Conn.

I wish to address the subject brought up by Steven Lubar in his letter of April 1979. He states: "The goal is still important, but the means have changed." By what ever means does Steven imagine that our goal will be accomplished? Who else will put Colony One up there? Congress? The Russians? or maybe The Ayatollah? If you think that those who are left with practically no technological muscle can do it, then you have a very romantic and very foolish idea of reality. Steven seems to lack grasp of the fundamental necessities of our position. We are balanced on the point of a very sharp sword: off to one side is technological revisionism and to the other side is Three Mile Island. Although corporate control may not be the ideal means, we seem to need some sort of symbiosis. Besides, after the goal is established, events may roll unheeded.

Keith Kuhn
Lewistown, PA

A problem with colony architecture that has occurred to me is that in a sharply curved space, you could hear all of your neighbor's stereos. Robert Heinlein might not appreciate me playing Jimi Hendrix and Led Zeppelin at the level at which I like hearing them. Sound insulation is a problem that can be solved, but it should have some attention paid to it. In the 21st Century, large colony sizes will hopefully reduce this problem.

Michael C. Emmert
San Antonio, TX

Our Society, and especially the **L-5 News** has the potential for enlightening a large block of future decision-makers, voters and leaders of the world in which space exploration and exploitation will truly begin. Now is the time to take this unabashed enthusiasm and imbue it with the understanding absolutely vital to making realistic decisions. How much more quickly could our Society's goals be accomplished if its members could see for themselves the ludicrousness of trusting a few government officials to decide what gets funded and by how much, when these same officials think a light-year is a unit of time, and don't have the foggiest notion of what kept Skylab in orbit, much less how it got there and why it came down? Who better to turn the imposters out than concerned, informed voters?

I would hope that my fellow members are of a caliber that even a pipe-fitter would want to understand what L-5 is, where it is, how he got there, and why it is important.

John B. Charles
Lexington, KY

I am involved in a year long study investigating our culture's responses to the photographs of planet Earth taken by the Apollo astronauts on their way to the Moon. I wish to know the ways in which various groups within our culture interpreted these photos. I would like to know who used them and what messages they attached to the photographs.

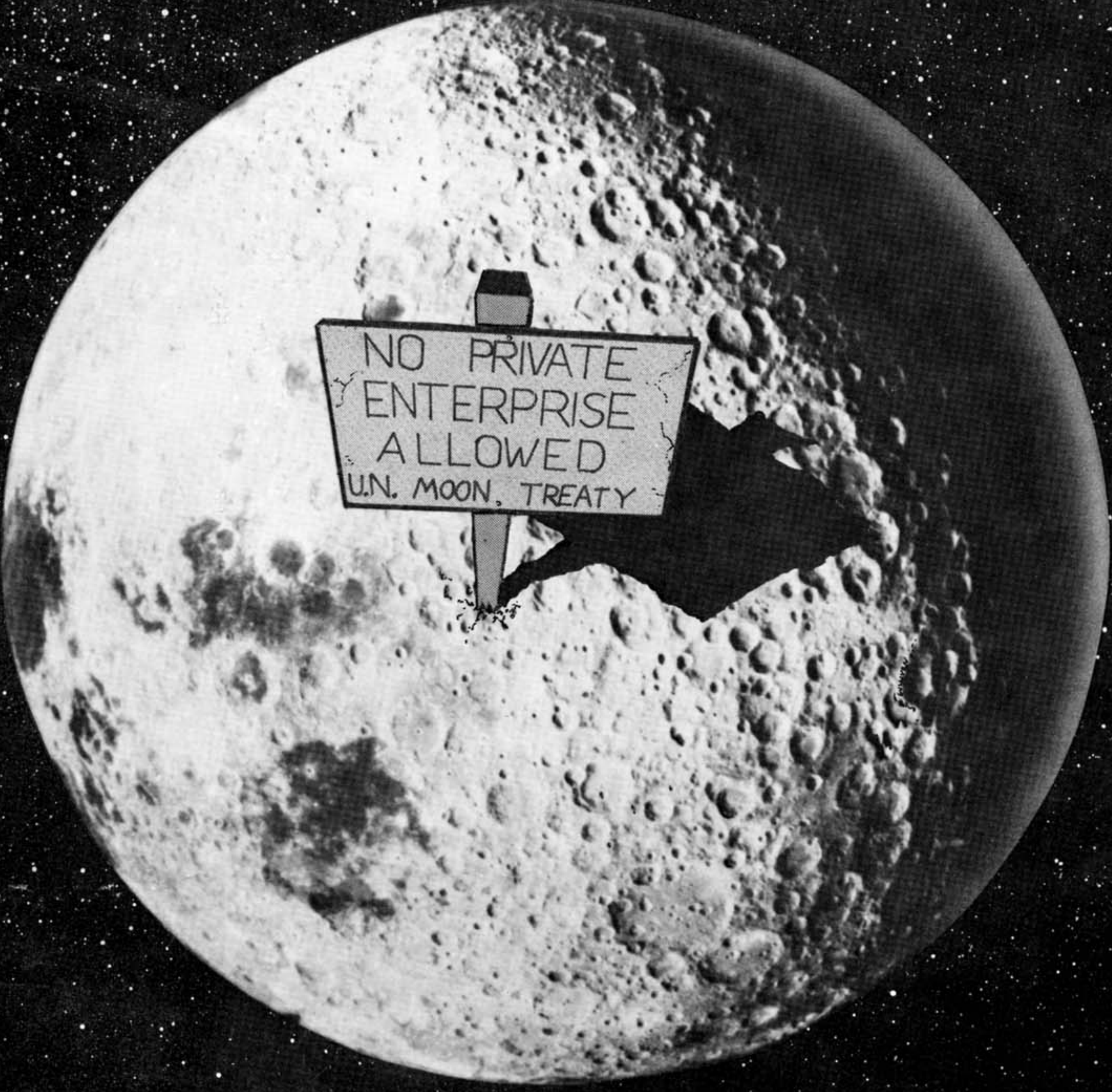
Currently I am gathering materials in which the photographs have appeared. I am interested in individuals and groups who have made use of the photos, e.g. poets, professors, media editors, environmental, religious, and/or space age communities, educators, corporate advertisers, etc. Any communication format is desirable, e.g. posters, books, flyers, magazine articles, buttons, shirts, brochures, stationary, memorabilia, etc.

If your organization has made use of the photographs or if you know of others who may have made use of the photos, I would be most grateful if you could help me locate and obtain examples of this material. If you have direct access to these items, and could send copies, that would be wonderful. If you know of other individuals and/or organizations who may be able to help, I would appreciate your forwarding this letter to them. My funds are limited, but I can cover some minimal acquisition expenses.

Steve Axelbaum
Box 25
Amherst, Mass. 01002

L5 NEWS

October 1979



LAWYER ART DULA REVIEWS U.N. MOON TREATY

L-5 DIRECTOR J. PETER VAJK DESIGNS FOR SUCCESS

L-5 NEWS

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9 **The Sunsat Energy Council's Letter to President Carter**

10 **Space Industrialization: How to Design for Success** *by J. Peter Vajk*

12 **Announcements**

15 **Inside the L-5 Society**

17 **Letters**

Cover: Will the Moon and other celestial bodies in the solar system be off-limits to private enterprise? See "Free Enterprise and the Proposed Moon Treaty" by Art Dula, page 1 of this issue. (Cover courtesy of Brian P. Sullivan)

Free Enterprise and the Proposed Moon Treaty

by Art Dula

Part I

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies ("Moon Treaty") was introduced in the United Nation Committee for the Peaceful Use of Outer Space ("COPUOS") by the U.S.S.R. in 1971. On July 3, 1979 a compromise draft comprising an introduction and 21 articles passed COPUOS by consensus and was sent to the General Assembly for adoption. The Moon Treaty is easily the most far reaching international agreement ever written. If ratified by the United States, the Moon Treaty's provisions will control the activities of the United States, as well as those of all U.S. citizens and organizations, not only on the Moon, but also on every celestial body in the solar system other than Earth and in the trajectories around and between them. It is hornbook law that any U.S. law or regulation contravening a ratified treaty is void. Thus planners who hope to exploit space resources commercially for profit through the free enterprise system would be well advised to study this Moon Treaty carefully and determine if its adoption would be in the best interests of the United States and the free world.

The Rescue and Return Agreement, the 1972 Liability Convention, the 1976 Registration Convention, and the Moon Treaty grew out of the "Treaty of Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies" ("Treaty of Principles"), which the U.S. ratified in 1967. By 1979 over 100 countries had bound themselves to abide by the "Treaty of Principles."

The history of the Treaty of Principles demonstrates the basic conflict that exists between the communist and capitalist philosophies concerning the exploitation of space resources. As introduced by the U.S.S.R. in 1962, the Treaty of Principles forbad free enterprise in space. The Soviet view was that only states should be permitted to engage in space activities. After the U.S. mooted this Soviet effort by chartering the Communications Satellite Corporation, a compromise resolution passed the U.N. and was ratified by the U.S. This compromise established significant barriers to the entry of free enterprise into space ventures. As ratified, the Treaty of Principles requires that all U.S. space activities, public or private, be authorized and continuingly supervised by the U.S. government and that the U.S. government bear unlimited international liability for damage caused by such ventures. Despite its drawbacks, the Treaty of Principles expressly mentions the Moon in several articles and thus clearly establishes a legal order for the Moon that is part of the positive federal law of the United States.

If ratified by the United States, the Moon Treaty's provisions will control the activities of the United States, as well as those of all U.S. citizens and organizations, not only on the Moon, but also on every celestial body in the solar system other than Earth . . .

Summary of the Moon Treaty

The Moon Treaty is vague, lengthy and complex. Many of its critical terms are not well defined. The language of its most important articles closely parallel similar language in the 1970 UN resolution on the deep seabed and the draft law of the sea treaty. The critical articles provide that:

1. The treaty applies to all celestial bodies in the solar system excluding the Earth.

2. All celestial bodies and their natural resources are the "common heritage of mankind."

3. No celestial body is subject to national appropriation by any claim of sovereignty, by means of use or occupation or by other means.

4. An international regime must be established to govern the exploitation of natural resources on or derived from celestial bodies before these resources are exploited for other than scientific purposes.

5. Neither the surface nor subsurface of any celestial body nor any part thereof can become the property of any state, corporation or private person.

Neither the Moon Treaty nor any other authority defines the terms "celestial body" and "natural resources" as they are used in the treaty.

"Exploitation" vs. "Use" of Natural Resources

One reason consensus was reached during the 1979 COPUOS session was that the Soviet Union accepted a Brazilian formulation of the treaty's "common heritage" language. This language is now in Article XI of the treaty:

"The Moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this article and in particular in paragraph 5 of this article."

Paragraph 5 of Article XI requires the establishment of an international regime, presumably via a second treaty, before exploitation of natural resources from space becomes feasible:

"States party to this agreement hereby undertake to establish an *international* *regime,* including appropriate procedures, *to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible.* This provision shall be implemented in accord with Article XVIII of this agreement (which sets up a time table and mechanism for generating the regime)." (emphasis added)

Consensus was also encouraged in 1979 when a number of third world countries dropped their insistence upon imposing a total *moratorium* on all use of space natural resources pending establishment of an international regime to govern exploitation of such resources.

The United States, through Neil Hosenball, NASA's General Counsel and chief U.S. representative to COPUOS, made a number of unilateral statements defining the United States' interpretation of several parts of the Moon Treaty. Two of these statements seem intended to contradict the clear language of the treaty regarding exploitation of space natural resources:

1. "The draft agreement—and I am particularly pleased about this, as a member of the National Aeronautics and Space Administration (NASA)—as part of the compromises made by many delegations, places no moratorium upon the exploitation of the natural resources on celestial bodies, pending the establishment of an international regime. This permits orderly attempts to establish that such exploitation is in fact feasible and practicable, by making possible experimental beginnings, then, pilot operations, a process by which we believe we can learn if it will be practicable and feasible to exploit the mineral resources of such celestial bodies."

The Moon Treaty is vague, lengthy and complex. Many of its critical terms are not well defined.

2. "We also note with satisfaction that Article XI, paragraph 8, by referring to Article VI, paragraph 2, makes it clear that the right to collect samples of natural resources is not infringed upon and that there is no limit to the right of states' parties to utilize, in the course of scientific investigations, such quantities of those natural resources found on celestial bodies as are appropriate for support of their missions."

Mr. Hosenball's statements were not contradicted. They form a part of the treaty's history.

The clear language in Article VI of the Moon Treaty specifically permits scientific "use" of lunar resources. Conversely, equally clear language in Article XI states that before "exploitation" of those resources is feasible, a new international legal regime must be negotiated. The U.S. position contradicts this treaty language by stating that the Moon Treaty places "no moratorium on the exploitation of the natural resources of the Moon, pending establishment of an international regime."

While the meaning of the Treaty's terms could provide grist for the mills of the U.S. Federal Courts for years, it is clear that the Moon Treaty sets no moratorium on *scientific collection* or *experimental use* of lunar resources. The Treaty also specifically allows states to use lunar resources to support their missions in the course of "scientific investigations." The Moon Treaty does not specifically mention *"commercial"* use of lunar resources or *"use for profit"* except insofar as it requires that an international regime be established to control lunar resources prior to their exploitation." The difference between the "exploitation" and "use" of lunar resources is critical. According to **Black's Law Dictionary**, "Exploitation" is:

In addition to limiting the "use" and forbidding the "exploitation" of natural resources from space, the Moon Treaty goes to great lengths to deny any possible legal entity the capacity of owning any part of these resources.

"The act or process of exploiting, making use of, or working up, utilization by, application of industry, argument, or *other means of turning to account,* as the exploitation of a mine or a forest." **State Finance Co. v. Hamacher**, 17 P. 2d 610, 613. (emphasis added);

while "Use" is:

"To make use of, of convert to one's services, to avail one's self of, to employ." **Hopkins v. Howard**, 99 S.W. 2d 810, 812.

Thus, exploitation is use "turned to account," i.e. commercial use that results in a *profit* accruing to the user. The framework of the legal regime to control exploitation of space resources would be laid out by a "Law of Outer Space" conference, which parallels several "Law of the Sea" conferences held over the past decade. The first such conference is set for 1982. The U.S.S.R. has offered to host the conference in Moscow.

Property Rights in Lunar Natural Resources

In addition to limiting the "use" and forbidding the "exploitation" of natural resources from space, the Moon Treaty goes to great length to deny any possible legal entity the capacity of owning any part of these resources.

Article XI, Section 3 states:

"Neither the surface nor the subsurface of the Moon *nor any part thereof* or natural resources *in place* shall become the property of any state, international, intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person." (emphasis added)

On April 19, 1973 the U.S. representative to the COPUOS legal subcommittee unilaterally contradicted the clear meaning of the words "in place" appearing in an earlier working draft of the Moon Treaty:

"As is apparent from the text, this working paper excludes the concept of a pre-regime moratorium. References to the words "in place" in the first sentence of the paragraph . . . make this clear. More particularly, the words "in place" . . . are intended to indicate that the prohibition against ascertation of property rights would not apply to natural resources once reduced to possession through exploitation either in the pre-regime period or, subject to the rules and procedures that a regime would constitute, following establishment of the regime."

These statements by the United States drew no response, and this silence is a part of the history of the treaty.

Ratification

COPUOS agreed in July, by consensus, to send the Moon Treaty to the United Nations General Assembly, which convened in mid-September. The General Assembly has approved the Lunar Treaty and has opened it for signature by states. For the treaty to be legally effective in the United States, the U.S. must sign the treaty and the Senate must advise and consent to it by a two-thirds majority.

If the Senate fails to ratify the Moon Treaty, it does not become positive law in the United States. Despite this fact, signing the treaty signifies the administration's intent to accept, and presumably abide by, the Treaty's terms. This intent will influence governmental policy with regard to the government's authorization of space resource exploitation by U.S. industry. Because NASA has a monopoly on space transportation, the practical results of the U.S.'s signing the Moon Treaty could be just as far-reaching as the effects of the treaty's formal ratification.

To be continued.

The Senate may vote on the proposed Treaty as early as January. You can write to your Senator to express your views at the following address:

U.S. Senate
Washington, D.C. 20510

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Space Foxholes
or
Beetle Bailey in Orbit

by H. Keith Henson

Few people realize the extent of the military involvement in space. Besides the well-known spy satellites, military communication and navigation depend on satellites. At any given time, over a billion dollars worth of U.S. hardware is circling the Earth. The defense of this stuff which has become vital to the military has a lot of people worried. To date, very little has been done about these worries because there have been no really good ideas of how to defend anything in space. (An operational definition of "good" is a positive cost/benefit ratio, i.e. do we get more out of it than it cost. Military activities are as constrained by economics as anything else.)

Six feet of common dirt around the sensitive parts of a spy satellite would make it immensely harder to put out of action . . .

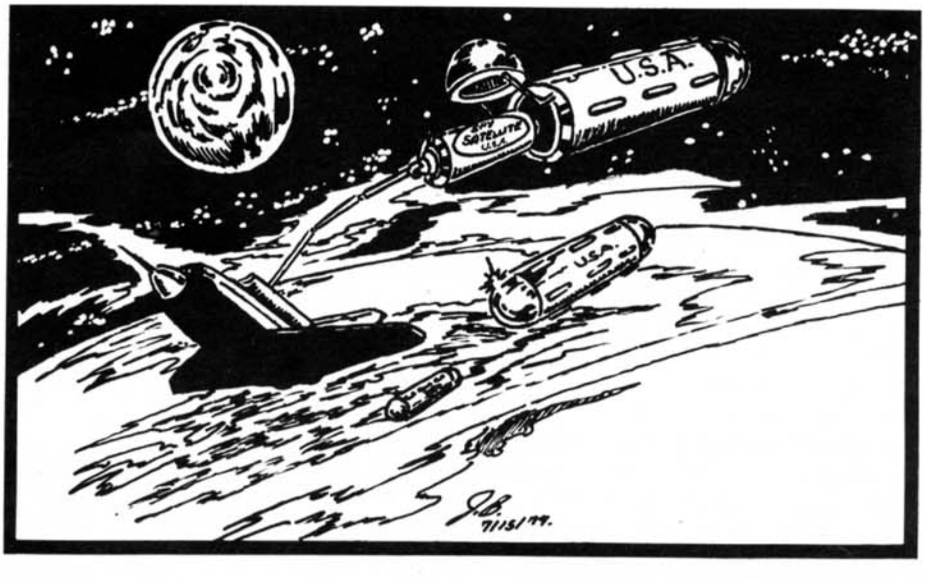
Given the array of possible antisatellite weapons, shrapnel, lasers, particle beams, ordinary high explosives and nuclear bombs, what defense methods would work for all of them? The obvious method would be the space foxhole or bunker. Six feet of common dirt around the sensitive parts of a spy satellite would make it immensely harder to put out of action by any of these weapons. The problem is that a 6-foot shell of dirt around an object the size of a shuttle bay would weigh around 1000 tons. Boosting this much mass into orbit would require about 70 shuttle launches and would cost about 2 billion dollars.

The advantages of armoring satellites are so great that it might be worthwhile even at this cost. Putting things in holes or under the sea where they are hard to knock out has a nonaggressive image. (Why bother if you are going to strike first?) The alternate response to antisatellite weapons is to threaten the other side's satellites with your own weapons. Those of you who read **Aviation Week** and **Space Technology** know that this is the path the U.S. is currently taking. This approach has little to recommend it, especially since the differences between the U.S. and U.S.S.R. spy satellites would make an exchange much more costly to the U.S. Our satellites are large, expensive, and long lived. The USSR tends to launch, on need, much smaller and shorter lived satellites and, unlike the U.S., keeps a ready reserve.

The use of extraterrestrial materials has not (to my knowledge anyway) been seriously considered for military applications. It is pretty obvious that if a method were available to get thousands of tons of dirt to the orbits used for spy satellites, a ready market would exist. As a guess, the military might be willing to pay 2 or 3 billion for 3-4 parking garages in orbit for its spy satellites, and perhaps half of that to armor its communication and navigation satellites. If this is a good guess, then the military market is the next largest, after solar power satellites (SPS). Furthermore, the material needs little or no processing to be useful.

The Earth and the Moon are not the only sources of dirt in the solar system. We have run our remote fingers through the sands of Mars and photographed the regolith of Deimos.

It's a long way from military space bunkers to what we are really interested in, the human habitation of space, but other than the SPS project, the space bunkers are the only other extraterrestrial resources project that might be economically justifiable. Extraterrestrial resources are, as we well know, *the* key to space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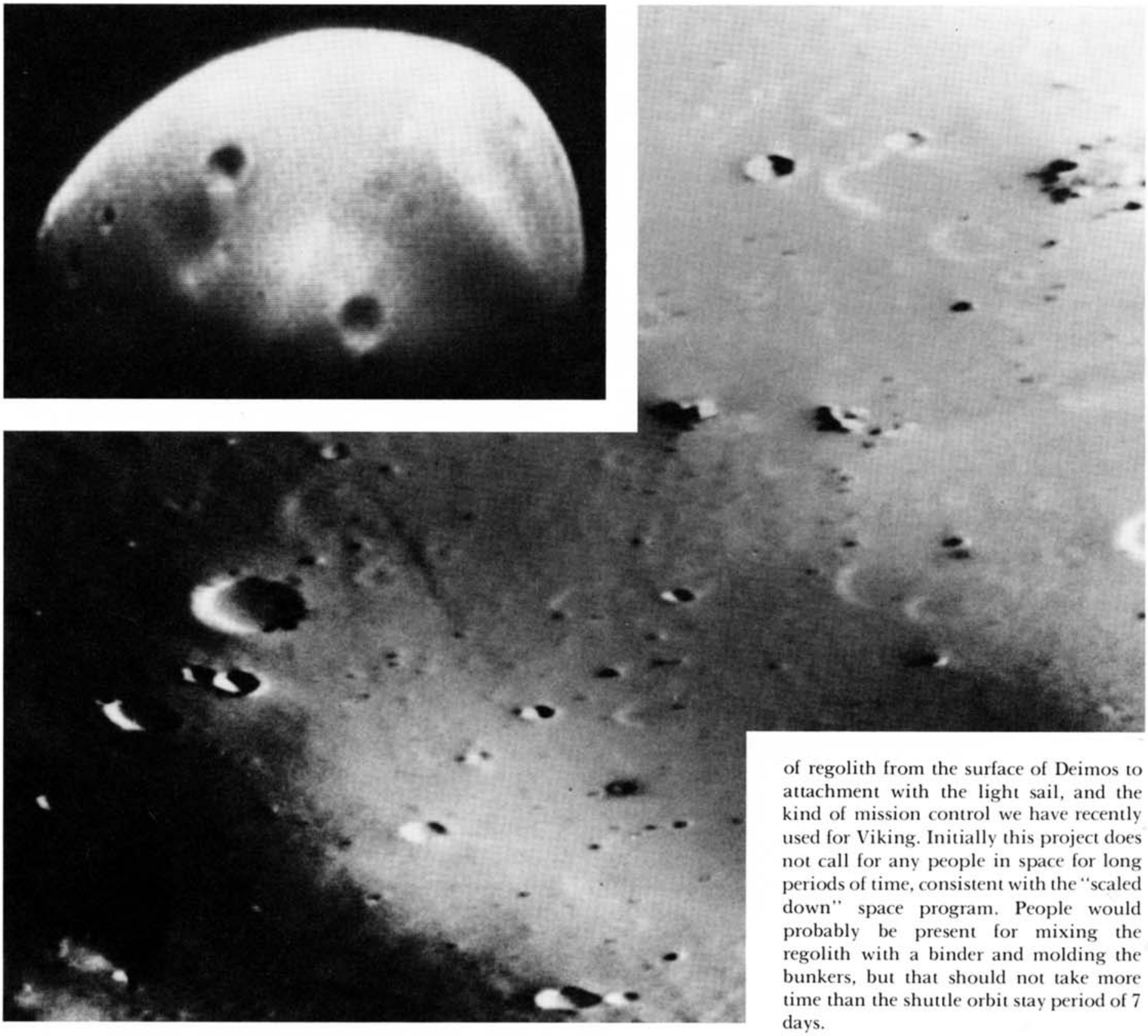


Above: The surface of Deimos photographed by Viking Orbitor 2. A layer of dust makes the surface appear smoother than the other Martian Moon Photos. Solar sails could transport regolith from Deimos at rates of 100-200 tons per month.
Insert: A computer-generated picture of Deimos from a pair of images taken by Viking Orbiter 1.

habitation.

A 3 or 4 billion market, large as this is, does not necessarily lead to an O'Neill-style space development (although it would help if,for example, an SPS project were in the works). The Moon base/mass driver cost estimates are in the range of three times the total market.

The Earth and the Moon are not the only known sources of dirt in the solar system. We have run our remote fingers through the sands of Mars and photographed the regolith of Deimos (the larger of the two Martian moons). In the context of solar sails, Deimos may be one of the most accessible objects in the solar system. Trip times for light sails would average four months on the outbound leg and a year on the inbound leg. Sail production rates of one per month would start returning material at a rate of 100 tons per month. As the sails begin to be reused, about a year and a half later, the rate would go up to 200 tons per month. This sort of thing could go on for a long time before we took a noticeable bite out of Deimos.

What would be needed for this project would be a solar sail production facility, remotely-operated carpet sweeper, a remote launch/docking tug to move bags of regolith from the surface of Deimos to attachment with the light sail, and the kind of mission control we have recently used for Viking. Initially this project does not call for any people in space for long periods of time, consistent with the "scaled down" space program. People would probably be present for mixing the regolith with a binder and molding the bunkers, but that should not take more time than the shuttle orbit stay period of 7 days.

There are numerous advantages to a program to mine Deimos by remote control. The existence of a transport system of light sails would make the wildest remote explorations of the outer planets feasible. A one and a half year flyby to Pluto would be one example. A Mars sample return could be tacked on to the program, probably at less cost than the Viking program. Sample returns from the asteroids would be easy as well.

The most significant advantage of this project is that it gives us a toehold in space. Once we have a steady supply line for extraterrestrial materials, we can build shielded habitats where people can live their lives without cosmic ray damage. We will possess the raw materials to build farms and factories. We will have made the step from being visitors in a hostile environment to being homesteaders in the promised land.

How to Be a Successful Inventor

"How? All it takes is skill, good advice, hard work and money"

by Carolyn Henson

Reprinted from Future Life Magazine, #13, September 1979.

Many frustrated inventors write to me because I'm president of the L-5 Society. And they're right, I do know how to help lone inventors. My husband is a full time inventor; his devices labor away in candy factories and tractor plants, monitor giant mine trucks and protect water pumps. His research shows up in the major space manufaturing technical works, as well.

I've had the pleasure of helping turn his schematics into hardware. How? All it takes is skill, good advice, hard work and money.

Let's work on skill first. Have you studied college level physics? I don't mean the creampuff courses they offer premed students; you have to take the stuff that requires calculus. Mechanics, electromagnetism, thermodynamics, optics and acoustics are essential. Beat it into your head until you can look at a scheme and immediately determine whether angular momentum is conserved or whether it obeys the second law of thermodynamics. Nine out of ten of the schemes people show me violate the laws of physics. They'll never fly.

Some kooks think the laws of physics are a conspiracy by evil scientists to keep reactionless drives and faster than light starships off the market. These people remind me of the Tucson gangster who bribed a building inspector to approve his bowling alley design. However, the law of gravity wasn't circumvented as easily as the laws of Tucson. The bowling alley collapsed.

Then there was the Arizona legislator who proposed the repeal of Carnot's law in order to save fuel.

Sharpen your skills with plenty of math. Learn to use Fourier and Laplace transforms, Bessel functions, Lagrangian interpolation and more. Study numerical analysis and how to get your computer to do the calculating for you. If you don't have something fancy on hand at least get a calculator with trig functions and a decent memory.

I remember when I independently thought up the idea of the tethered geosynchronous satellite — the "skyhook" concept. That is, I got an intuitive grasp of the idea. But I couldn't determine whether we had any materials strong enough to build the skyhook because the solution to the problem involves integrating over a diminishing gravity field, and I couldn't integrate. My husband found an article in **Science** for me where the math had been worked out. It was Greek to me. But I got the message: I spent the next four years buried in math books.

Yes, there are math kooks, too. I had to throw an old man out of my office because I tired of his demands that I join his crusade to declare pi equal to exactly 3.14. "There are no irrational numbers in nature," he declared.

Could you sign checks and write contracts when 9 months pregnant and in labor with contractions five minutes apart? If the answer . . . is yes, you're probably not **too** *lazy.*

You absolutely must have good advice. Many inventors go wrong because of obvious flaws in their concepts that a skilled friend could probably spot. One of the major reasons to attend technical conferences is that they are the perfect place to make friends who can help you turn that rough idea into real hardware someday.

Don't let pride trip you up. No matter how brilliant a researcher may be, he or she always looks to friends for advice.

Next comes the hard work. Could you do without your yearly vacation in the Bahamas? Do you mind working Saturdays? Can you survive on only six or seven hours of sleep a night? Do you mind scarfing down a cold taco and a warm soda pop with your left hand while you type data into the DEC-10 with your right? Could you sign checks and write contracts when 9 months pregnant and in labor with contractions five minutes apart? If the answer to all these is yes, you're probably not *too* lazy.

Last we tackle the money problem. People with sound, ingenious inventions write and call me with the same old sob story. "NASA won't give me a cent." "My wife left me because I spent our life savings on my invention." "The aerospace companies don't even answer my letters." So what else is new?

Peter Glaser, inventor of the solar power satellite, promoted it four years before getting a cent of NASA money. Gerard K. O'Neill, world famous space colony researcher, traveled around the country pushing his ideas for six years before getting his first grant.

How about Peter Vajk, the space industrialization pioneer? He lost his job at Lawrence Livermore because he spent too much time working on space colonies. T.A. Heppenheimer was fired by Rockwell for the same reason. But they didn't waste time feeling sorry for themselves. Heppenheimer is now working full time on space colonies as an independent consultant, has written a lucrative book, **Colonies in Space** and has another, **The Colonists**, about to hit the bookstands. Vajk was snapped up by Science Applications, Inc., which needed a space industries expert, and he wrote **Doomsday Has Been Cancelled** in his spare time.

I enjoy asking the authors of space industrialization research papers who funded their work. Often they reply "Oh, I did this research in my spare time. Hope the boss doesn't find out I swiped some computer time."

When my husband started his electronics company, Analog Precision, we had no money. But we needed a building and tens of thousands of dollars worth of test gear, circuit board facilities, machine tools . . . what a list of things! So we cut our living expenses way down — below the poverty line — remortgaged the house, borrowed up to our ears from the bank and all our friends, borrowed the equipment we couldn't buy, and hustled like crazy.

It worked!

It can work for you, too. Reach for the stars!

The Asteroid/Meteorite Connection

by Stewart Nozette

The concept of a relationship between asteroids, and the meteorites in our museums forms the basis for one of the most fascinating questions in contemporary planetary science. Where do meteorites come from? Answering this question may give us the basis for asteroidal utilization.

We all know that the cost of planetary exploration is extremely high. If the solar system is to be *thoroughly* explored, and if we are to make many direct observations of asteroids, an economic motivation must be present. The asteroids may provide an excellent resource base for future industrial activities in space. However, a gap in our knowledge exists concerning the physical and chemical nature of asteroids. The imagination of planetary scientists, along with the free samples residing in our museums, may help unravel the secrets of the asteroids, and provide the vital information useful in exploitation of extraterrestrial resources.

The imagination of planetary scientists along with the free samples residing in our museums may help unravel the secrets of the asteroids . . .

Meteroites may be divided into three catagories: stones, irons, and stony-irons. These categories have been recognized almost as long as people realized that rocks could indeed fall fromthe sky. Of the stony-type meteorites, the most abundant are the ordinary chondrites. These are made up primarily of silicate minerals with varying amounts of iron-nickel metal and iron sulphide. Chondrites are distinguished by the presence of millimeter-sized spherical bodies called chondrules. The origin of these chondrules is a highly debated subject, but impact and igneous processes may have been responsible. Some of the ordinary chondrites show evidence that they have been geologically processed, i.e. metamorphosed. The ordinary chondrites are thought to represent primitive planetary material which never experienced large amounts of remelting. Chondrites may be the building blocks of planets.

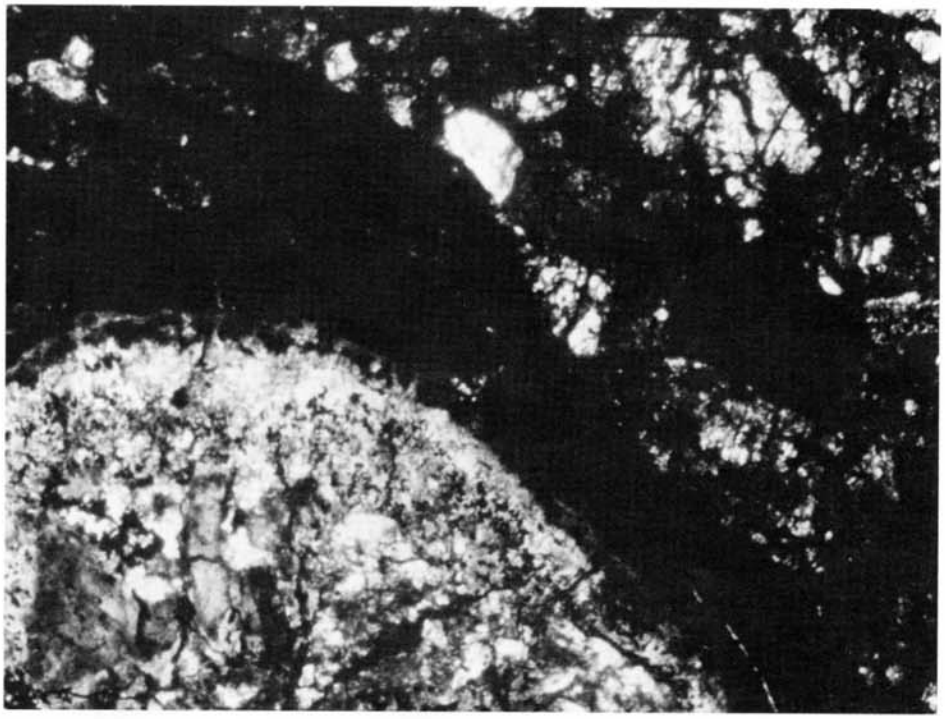
Other types of stony meteorites include the carbonaceous chondrites and the achondrites. Achondrites appear to have been produced by igneous processes similar to those found on the Earth and the Moon. One group of achondrites, the Eucrites, appear to be pieces of solidified magma produced on a small planet. This hypothetical planet is imaginatively called the Eucrite Parent Body. There is a continued debate on just exactly where the Eucrite Parent Body is, or whether it still exists at the present time. This mystery arouses intense fascination in the author. To think that we actually possess pieces from the surface of a distant planet! This planet may no longer exist, having possibly been destroyed in a primeval collision.

The carbonaceous chondrites often stimulate the highest level of interest in those interested in economic ventures in space. These meteorites appear to represent the most primitive solar system material we have seen. This is not to say that they do not have complex histories, but that they have never undergone extensive heating. The carbonaceous chondrites would provide an excellent source of volatiles for space activities. Some contain as much as 15% water by weight. This water may be converted into hydrogen for chemical propellent, and oxygen which may be used for life support and industry. One small carbonaceous asteroid could make space industry completely independent of terrestrial raw materials, except for special use items.

To think that we actually possess pieces from the surface of a distant planet!

The iron-rich meteorites also represent a

Figure 1 *A photomicrograph of a piece of carbonaceous chondrite in the Plainview ordinary chondrite. This might have formed on the surface of an asteroid.*



mother lode of raw materials. That huge hunk of iron which you may have seen in a museum is probably a piece of the core of a small planet which was shattered by collision millions of years ago. Civilization may never want for metal if we can utilize the source of iron meteorites.

The meteorites show evidence that they originate on large planetoids. We must now extract more subtile information from meteorites to tell us what the actual surfaces of these bodies are like.

When the first astronauts landed on the Moon, they found a surface composed of loose broken-up material known as regolith. The nature of the lunar environment, with its vacuum and exposure to the solar wind, produces distinct features in this regolith. These include evidence of impact, cosmic ray radiation damage, and high abundances of solar wind gases, i.e. helium. The regolith has been churned and broken over eons of bombardment. This bombardment produces special rock types called breccias, characterized by angular mineral grains cemented together with glass.

The surface environment of an asteroid will be similar to that of the lunar surface except for the asteroid's lower gravity. There are meteorites which show evidence that they formed in a regolith. This evidence includes brecciation, large amounts of trapped solar wind gases, and the presence of foreign fragments. Figure 1 shows a piece of carbonaceous chondrite found inside of an ordinary chondrite. The carbonaceous piece shows evidence of exposure of liquid water, produced possibly by heating during an impact.

Using the lunar example and evidence from meteorites, a model has been constructed for asteroid surfaces. This model gives clues to the type of surface which may be found on an asteroid of a given size and age. The model suggests that large asteroids around 300km. in diameter will develop 2km. thick regolith blankets in the first 2 billion years of evolution. Later the surface will erode and eventually a collision will shatter the asteroid. A smaller body, about 100km. in diameter, accumulates much less regolith because less crater ejecta is retained in the weak gravity field. Smaller bodies lose nearly all their crater ejecta because of their tiny gravitational fields. Asteroids 1 to 10km in diameter are predicted to have very thin **layers of regolith. A small body made up of weak material like carbonaceous chondrites will have more regolith. This** model does a good job of predicting the astronomical properties of asteroids and the mode of formation of the brecciated gas-rich meteorites. A mining operation may simply be able to scoop up thin 2m. regolith layers. Thus, even a small body may have an easily exploitable surface.

Civilization may never want for metal if we can utilize the sources of iron meteorites.

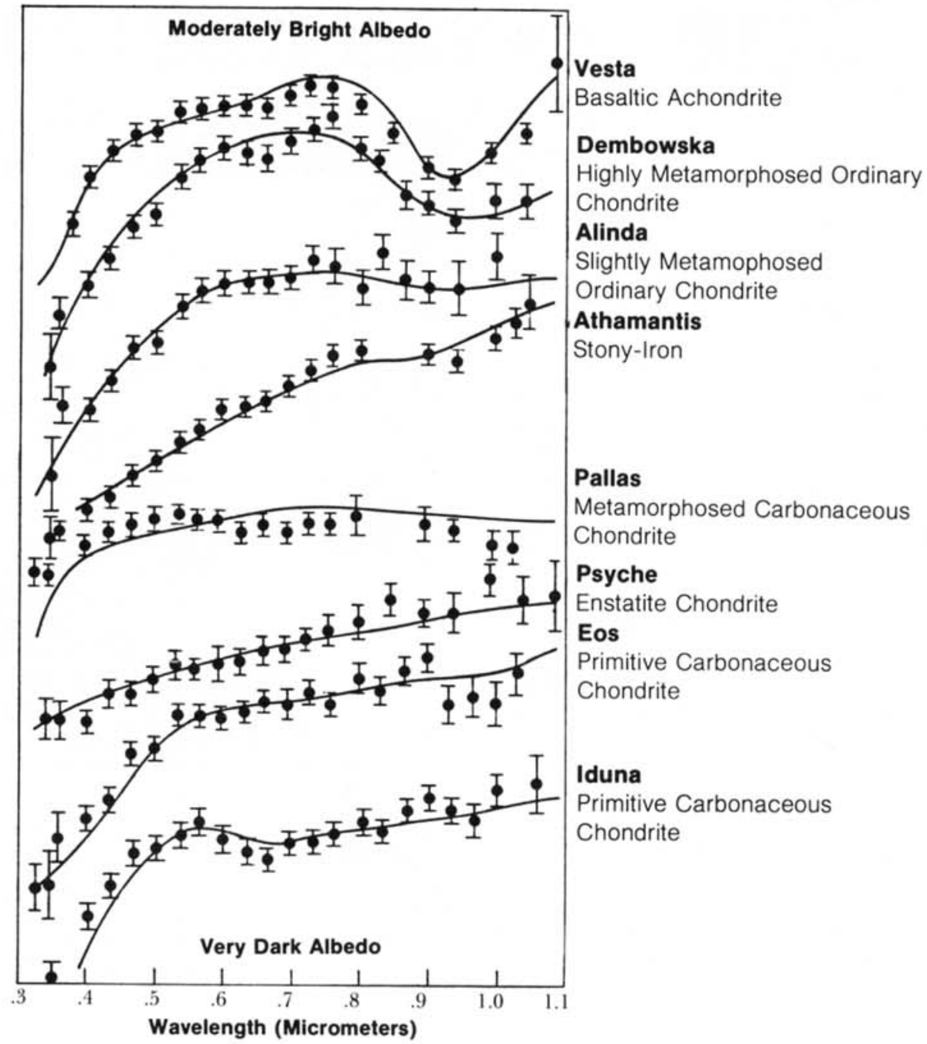


Figure 2 *Asteroid and meteorite reflectance spectra. The points are astronomical measurements; the lines are meteorite reflectance spectra.*

We have discussed the physical properties of the asteroid surface inferred from meteorite evidence. What may we say about the chemical properties of these surfaces? Almost all of our current ideas concerning asteroid composition stem from spectro-photometric observations. These observations are carried out by Earth-based telescopes equipped with sensitive light-measuring equipment. The intensity of light reflected by the asteroids at different wavelengths is measured. The spectra obtained may be compared to laboratory spectra of meteorites. Figure 2 shows just such a comparison. The points represent astronomical measurements and the lines are meteorite spectra. These reflectance spectra are fingerprints which allow us to make educated guesses about what the surfaces are made of. By examining figure 1, we can see a fairly good match between asteroids and meteorites.

We still have a long way to go in understanding the asteroids. The evidence accumulated on the Earth will provide future asteroid prospectors with their basic information. The economic exploitation of these materials will provide an almost unlimited resource base for future generations and allow the scientific **exploration of the solar system to proceed with fewer budgetary restrictions.**

Chapman, Clark R. "The Nature of the Asteroids, "Scientific American, Vol 232 No. 1 (Jan. 1975).

Housen, Kevin R.; Wilkening, Laurel L.; Chapman, Clark R.; and Greenberg, **Richard. "Asteroidal Regoliths," Icarus in press.**

Stewart Nozette has recently received his bachelor's degree in planetary sciences from the University of Arizona and will begin graduate work at MIT in the fall.

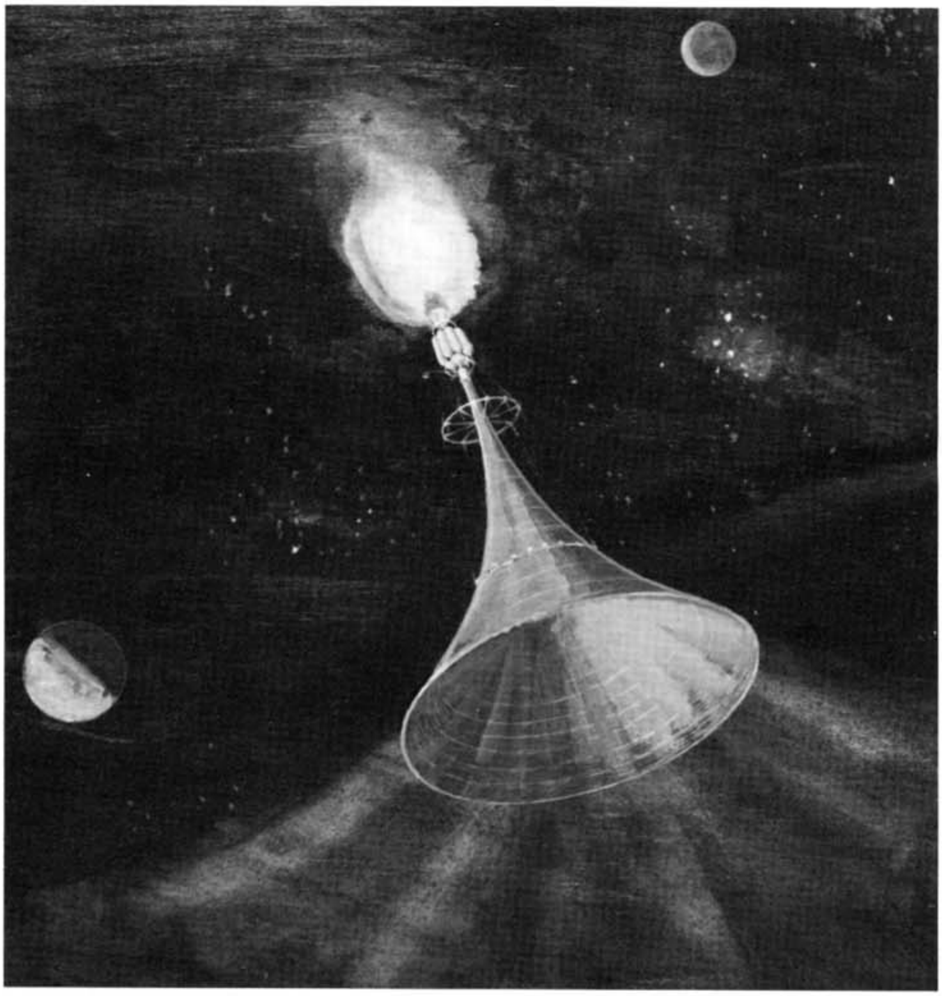
On to the Stars!

Dr. Robert W. Bussard, pioneer in nuclear propulsion, proposes that the natural evolutionary drive that led humankind to dominate the planet Earth will lead us to the stars. In an inspirational talk prepared for the 15th Annual Propulsion Conference held in the Las Vegas Sahara Hotel on 18-20 June 1979, Dr. Bussard explored our past and opened up wide-ranging visions of our future destiny in space.

Three large professional engineering societies engaged in ground, air, and space propulsion: the American Institute of Aeronautics and Astronautics (AIAA), the American Society of Mechanical Engineers (ASME), and the Society of Automotive Engineers (SAE), jointly sponsored the propulsion conference. Dr. Bussard was one of the featured speakers at that conference's "Propulsion Concepts for Galactic Travel" session.

Bob Bussard pointed out that the rise of the human race as an intelligent toolmaking animal has occurred over a remarkably short time span. Billions of years were required for evolution that started in the primordial mud, passed through the mammals and the great apes, to yield homo sapiens (us). Yet it only took ten thousand years for our intelligence to control the resources of an entire planet.

Bussard feels that the same drive will lead us to the stars. It is only a matter of time, energy, and survival. If we do not destroy our civilization in a global war, then he sees us engaging in journeys through the vast reaches of interstellar space to build civilizations on other worlds.



The Bussard Interstellar Ramjet

This concept would provide a means for interstellar space travel. The large cone depicted would scoop up hydrogen from the interstellar medium for use as fuel for a thermo-nuclear fusion powered rocket engine.

Dr. Bussard is aware of the difficulties of interstellar travel. He is also aware of the great technological capabilities of the human race that will make such journeys possible. He points out that we already know the technical directions to follow which can lead to starships capable of carrying humans to other stars and eventually throughout the galaxy.

Dr. Bussard's talk also raised an interesting speculation on the uniqueness of the human race. Calculations show that if an intelligent species has a drive similar to humanity's, and starts to explore other stars, then within 1 to 10 million years (a very short time compared to the 10 billion year age of the galaxy), the descendents of those first explorers would have explored every habitable planet in the galaxy. This leads him to speculate that perhaps it may be that we are the first of the intelligent species, and it is our destiny to explore and populate the habitable planets in the galaxy.

Dr. Bussard has worked on nuclear propulsion for aircraft and spacecraft since 1952, and has published two textbooks on nuclear propulsion. In a seminal 1960 paper, he proposed the now-famous Bussard interstellar ramjet. Prior to founding his own company in 1974, he was Assistant Director of Development and Technology for the U.S. Atomic Energy Commission, where he created, directed, and managed all engineering research and development activities in the U.S. controlled thermonuclear fusion program. He is Founder and President of Energy Resources Group, Inc., which carries out technical analyses and design studies of nuclear, solar, and advanced energy systems, and is Founder and President of International Nuclear Energy Systems Company, Inc., which carries out research and development of novel fusion power systems. They are currently working on a "throwaway tokamak." This is a compact, low-cost, fusion reactor that uses the design philosophy of propulsion engineering rather than power plant engineering.

The Sunsat Energy Council's Letter to President Carter

July 13, 1979

The President
The White House
Washington, D.C. 20500

Mr. President

Encouraged by the positive findings of scientists and engineers throughout the world, the Board of Directors of the Sunsat Energy Council has authorized me to urge you to consider in your energy planning one of the most promising concepts yet developed for harnessing a safe, renewable source of electrical energy: the solar power satellite. In a number of respects, this advanced space technology affords the United States an extraordinary opportunity to accomplish several national goals with a minimum of economic or other risks.

Assuming the concept is as valid as many leaders of the world technical community believe, a single solar power satellite in space could beam to Earth usable electrical energy in amounts ranging from 1/10 to 10 times that which might be generated by existing individual fossil or nuclear power plants. There are, of course, certain unknowns which would have to be explored before any attempt to put in place such a satellite could or should be attempted. However, these unknowns are fewer and less hazardous potentially than those, for example, associated with our initial commitment to the Apollo program or those which still exist in connection with nuclear waste disposal or the carbon dioxide effects of burning fossil fuels.

A federal expenditure of between $200 and $300 million over the next five years would cover the research necessary to determine the safety and feasibility of constructing a solar power satellite. Although the Sunsat Energy Council is committed, by its charter, to foster the exploration of such a satellite, none of its members would be so rash as to propose—particularly in the light of the events of recent months—proceeding without a well-conceived research program which, for example, would cover conclusively the effects of microwave, laser or other power transmission means on communications and the Earth's ecology.

Although it would be unrealistic to expect to have a solar power satellite in effective operation much before the end of this century, your announcement now of our committment to move ahead with deliberate speed on this project would have immediate positive effects—on our nation and the world.

It would reaffirm United States technological leadership. As you know, high technology products are among our leading exports. Enhancing our prestige in that field could favorably affect our trading position. Based on the work being done by the Department of Energy and the National Aeronautics and Space Administration as part of the ongoing evaluation program which addressed the technical, economic, and societal issues raised by the solar power satellite, you can be assured that the known facts would back up your words.

Such a statement by you at this time also would restore to the people of this nation a sense that the United States will move actively and decisively to control its own destiny, and that it is capable of dramatic undertakings toward an objective which could be of benefit to all nations.

In addition, such a move could serve notice to oil producing nations that our dependency may not be everlasting and that oil kept in the ground may not necessarily remain as valuable as it is today.

Even assuming, as we frankly do not think possible, that the solar power satellite does not prove feasible in the projected time frame, the spinoffs resulting from the initial work would more than justify the relatively modest research expenditure required. For example, new materials could be developed in space with applications on Earth. Advanced solar cells developed for the solar power satellite could also be used in commercial and residential buildings. We could learn more about the capabilities of man to perform complex tasks in space and more about the problems of placing large payloads in space.

I would be happy to provide any additional information you may want about the solar power satellite. And, if you would like to discuss the subject, my colleagues and I would be honored to meet with you at your convenience.

Respectfully yours,

Peter E. Glaser
President
SUNSAT ENERGY
COUNCIL

Space Industrialization: How to Design for Success

Current legislation reduces the risk of R&D by reducing the costs of failure. How could we turn the process around to reward success instead of failure and to stimulate entry into space manufacturing?

by J. Peter Vajk

Communications satellites are accepted today as a virtually "traditional" sector of the global economic system. It is difficult to recall the struggle of the early 1960's to encourage the development of a global communications satellite system in spite of the fact that we could see the technological feasibility and social desirability of deploying such a system. In 1963, Congress enacted the Communications Satellite Bill which created COMSAT, a private company to represent the United States in a worldwide communications satellite system. Two short years later, the first commercial satellite, Early Bird, was launched, initiating private sector improvement in outer space.

The post-war economic successes of countries such as Sweden and Japan have been predicated upon vigorous encouragement of technological innovation by deliberated government policy. For whatever reasons, the United States has not chosen to follow that path . . .

Today we are struggling with the next step in the economic use of outer space, as we stand on the verge of space shuttle operations and consider the possibilities of manufacturing products in orbit. From a technical point of view, we realize that the environment of low-Earth orbit offers some unique advantages, including weightlessness, ultrahigh vacuum, biological isolation, a wide range of temperatures, and a wide range of radiation environments. These can be exploited in new processes for converting a variety of raw materials into finished products of high intrinsic value per pound. Among the hundreds of possibilities considered thus far (and the thousands yet to be considered), we expect that some will prove to be commercially successful, providing new products, superior products, or less expensive products than we can manufacture here on the ground.

The key problem which the Space Industrialization Bill of 1979 (H.R. 2337) attempts to deal with is what kinds of new institutional arrangements can most rapidly and effectively bring the results of government-funded space research into commercial use? The post-war economic successes of countries such as Sweden and Japan have been predicated upon vigorous encouragement of technological innovation by deliberate government policy. For whatever reasons, the United States has not chosen to follow that path, and our leadership and economic advantage in a number of high-technologies has slipped so far that inflationary protective tariffs have been proposed to protect our domestic manufacturers from the reduced costs produced by vigorous innovation abroad.

I am an advocate of large-scale extension of human civilization and human affairs into outer space. My impression, from giving dozens of lectures to civic group, college, high school, and elementary school audiences over the last four years, is that the grassroots will vigorously support a space program geared to pragmatic, profitable ventures with visible and prompt benefits to people on Earth. Scientific exploration of the solar system and of the universe from space-based observatories are also of interest, but these would be far more acceptable in the presence of a vigorous program designed to exploit our capabilities, experience, and know-how. The Space Industrialization Bill of 1979 is a valuable step toward this goal and I sincerely hope that such a bill will be enacted into law in the near future.

However, I am offering some criticisms of the Bill as presently drafted in the hope that some modification will improve and accelerate the desired effects of the Bill.

In designing a new institutional arrangement, we must be very careful to design it for *success*. To do that, it is necessary to consider very carefully a long string of "What if . . . ?" cases to determine whether or not the proposed scheme will, in fact, discourage failures, inhibit cheating, and reward success.

(A beautiful example of this type of analysis is **The Federalist Papers** written by several of the architects of the United States Constitution. This type of analysis, which examined in detail how the self-serving interests of less-than-perfect politicians, judges, legislators, states, and factions could lead to various failures of the whole system, resulted in the exquisite system of checks-and-balances which have served this nation so well for so long.)

Let me give one brief example—perhaps controversial—of a system which appears to be designed for failure rather than success. Many critics, including such respected economists as Nobel laureate Milton Friedman, have described the present federal policy toward energy as just such a design for failure. In a nutshell, the *worse* the energy crisis gets, the *more successful* the Department of Energy (DOE) becomes. Its appropriations, staff, and regulatory power grow ever larger the further away DOE brings us from a viable solution to providing the energy we need and want. Should DOE somehow find a breakthrough solution to the problem, its survival as an entrenched bureaucracy would be severely threatened. Although all its employees may have the best of intentions and may strive sincerely to solve the energy problem, the system is designed to reward failure, not success.

. . . the worse the energy crisis gets, the more successful the Department of Energy . . . becomes.

It is my concern here that the Space Industrialization Corporation as proposed by the present draft of H.R. 2337 may in part be designed for failure rather than success. At the present time, space manufacturing is generally perceived by U.S.

industry to be "too risky" and it is the legitimate aim of the present bill to reduce that risk and thus to stimulate entry of the private sector into this new field of commercial activity. As in gambling, risk assessment in the business community must consider two factors: (1) How much can we afford to lose? (2) On a probabilistic basis, what is our *expected* gain or loss from this particular investment option? If I wager $1 on some particular number in a roulette game in which the wheel carries the numbers one through thirty-six, zero, and double-zero, I have one chance in thirty-eight that my number will win, and thirty-seven chances in thirty-eight that my number will lose. If the payoff for winning is thirty-eight to one, then my expected winnings are exactly zero, and the game is balanced evenly between the bettor and the house. I have a 37/38 chance of losing my $1, and the house has 1/38 chance of losing $37. The bet is "fair," but I dare not bet more money than I can afford to lose completely, *no matter how fair the bet may be.*

[If] a . . . corporation did invest the necessary funds to bring a space product to commercialization . . . the economic returns would be modest because of present tax laws. Thus the returns would be no higher than those of conventional, tested, Earth-made goods.

Now consider the opportunity for a company to invest in R&D to develop a new technology to the point of commercial profitability. Suppose market research shows that the company could earn $50 million if the venture succeeds. Suppose the chances of success are estimated (strictly on an intuitive or "hunch" basis) to be one chance in five. On that basis, the company would still break even on an expected winnings basis if it had invested $10 million in the R&D program. (I am deliberately ignoring such subtleties as interest costs and taxes to keep the basic argument simple.) A prudent investor would require that the R&D budget be somewhat less than $10 million or that the prospective earnings be somewhat greater than $50 million before making the investment in order to end up *better* than event, that is, to end up with a profit, a positive return on investment. He or she would also check the overall financial condition of the company to determine whether or not the company could afford to lose completely the funds invested.

If we now contemplate an investment in a new, untried process for the manufacture in orbit of a new or improved or reduced-cost product, we must ask the same questions. How much can we afford to lose completely? What do we expect to gain from the investment, weighing the chances of success against the chances of failure? In the present environment, space manufacturing is generally perceived as "too risky." The common perception in business and industry today is that the development costs for space manufacturing would necessarily involve millions of dollars of investment before any chance of economic returns, and this sum is in many cases more than medium-sized corporations are willing to lose, no matter how large the payoff may be. Yet a series of well-conceived experiments to develop and test some space manufacturing processes would necessarily involve millions of dollars of investment before any chance of economic returns, and this sum is in many cases more than medium-sized corporations are willing to lose, no matter how large the payoff may be. Yet a series of well-conceived experiments to develop and test some space manufacturing processes for products of high intrinsic value could be carried through for as little as $500,000 to $1 million, particularly if the red tape requirements of NASA could be reduced.

Suppose, however, that a medium- to large-size corporation did invest the necessary funds to bring a space product to commercialization. Unless the product were totally new (implying much higher risks of market acceptance as well as of technical development), the economic returns would be modest because of present tax laws. Thus the returns would be no higher than those of conventional, tested, Earth-made goods. In this context, given the higher uncertainties of the R&D phase, any prudent investor would rather put his or her money into a more conventional investment.

The proposed legislation under discussion here today approaches the problem of risk strictly from the viewpoint of reducing the costs of failure, by forgiving the full amount of a "loan" from the Space Industrialization Corporation. I believe this is a serious flaw; it rewards failure of the R&D program by removing the pain of failure, but provides no rewards, over and above those modest returns of any conventional manufacturing enterprise, for a successful effort.

Moreover, this approach encourages cheating, especially by smaller companies. Suppose a small company were formed for the primary purpose of carrying out some space manufacturing activities on a commercially profitable basis, and suppose this company received a loan from S.I.C. in the amount of several million dollars. Suppose that halfway through the planned R&D phase this company realized that the project would result in a fantastic new product which will earn millions and millions of dollars within just a few years.

The temptation would be very strong to begin at this point to maintain two sets of books on the progress of the work, especially with respect to flight experiments. In one set, the true results and progress of the work would be recorded, analyzed, and elaborated. In the other set, forged results would show (during the next 40% of the total funding available) ambiguous results gradually dwindling down to a dead-end failure. Under the terms of the loan from S.I.C., the remainder of the funding would be cancelled, and the company's only obligation would be to document the "failure," and the loan would be forgiven. Soon thereafter, the company could dissolve completely, and the principals in the company, possessing highly valuable trade secrets, could form a new company which completes the necessary R&D from entirely private funding to go into business manufacturing the end product in space, without the inconvenience of sharing their secrets with anyone else or the inconvenience of repaying a loan of several million dollars.

This is not to suggest that the private sector is dishonest; but I think it is most unwise to create an institutional arrangement which rewards failure and provides incentives for cheating.

How could we turn the process around to reward success instead of failure and to stimulate entry into space manufacturing? First we should note that small companies characteristically are more willing to invest in risky ventures than are giant corporations. If a small company makes unwise investments, it can always file for bankruptcy; a large corporation which loses several tens of millions of dollars will survive and have to face its irate stockholders at the next annual meeting. If the Space Industrialization Corporation has an annual budget of $50 million initially, it would be reasonable to expect that most of its grants will fall between $0.5 and $5

. . . it is most unwise to create an institutional arrangement which . . . provides incentives for cheating.

million. On this scale, most of the awards would go to small- or medium-sized companies; a few might go to the giants of industry, but these are unlikely to be interested unless the prospective earnings in the event of success are much greater than for conventional alternative investments.

Profits and jobs resulting from successful space ventures would be additions to the economic base; to refrain from taxing these . . . would not take away tax revenues since there would otherwise be no profits to tax.

Suppose, then, that S.I.C. loans were required to be repaid in all cases, preserving some of the pain of failure. (That pain could be reduced somewhat by providing the loans at low interest rates with long periods allowed for repayment.) Large companies would find such financing of the R&D costs appealing; small investors would be sheltered from total failure by the bankruptcy laws just as effectively as if the S.I.C. totally forgave the debt. Yet the incentives for cheating would be largely eliminated.

To encourage success, suppose all revenues from space manufacturing operations were granted tax-free status for, say, ten years beginning from the date of the first operational Space Shuttle flight, and 75% exemption for the next five years, etc. The profitability of space ventures would immediately be more than doubled in view of the 46% corporate profits tax, encouraging participation by all sizes of companies. The limitation of ten years, say, before the extent of tax forgiveness were reduced would encourage early entry into the market in order to maximize gains before taxation is phased in.

Some might argue that exempting profits from space ventures provides an indirect subsidy to industry at the expense of other taxpayers. I would suggest that this is not the case at all, because if no incentives were provided for space manufacturing, no profits or jobs in this field would materialize either. Profits and jobs resulting from successful space ventures would be *additions* to the economic base; to refrain from taxing these (at least in the early stages) would not take away tax revenues since there would otherwise be no profits to tax.

What should the role of the Space Industrialization Corporation be if we reward success as I have suggested above? S.I.C. should still, I believe, provide "seed money" for the development of space manufacturing processes, with low interest rates in the event of failure and normal interest rates in the event of success. Besides financing the technological R&D effort, however, S.I.C. can contribute to risk reduction by funding careful market surveys to determine the scale of earnings to be expected if the R&D effort succeeds. Uncertainty about the anticipated revenues in the event of success is a major factor in the present assessment of space manufacturing as "too risky."

I believe that S.I.C. would be most effective in carrying out the purpose of the Bill if it were required to award 90% of its funding to private companies, with no more than 10% spent in-house for administrative costs, project review and coordination, and R&D. In order to improve the efficiency of the organization, its employees should not be included in the Civil Service system, especially in view of the intent to move the Corporation out of the federal government and into the private sector after a few years. In order to minimize the problems of entrenched bureaucracies, a "sunset" clause should be added to the Bill, terminating the Space Industrialization Corporation not more than twenty years after its formation.

In order to allow space industrialization to grow as rapidly as it can, without ceilings imposed by politically determined appropriations and impoundments, I believe it would be most desirable to authorize the Space Industrialization Corporation to issue long-term "space bonds" backed by the full faith and credit of the U.S. Treasury. Given the requirement of full repayment of S.I.C. loans, and given reasonable judgment by S.I.C. in the selection of its investments, the actual subsidy involved in the form of loan defaults would be quite modest. Once S.I.C. has moved over into the private sector, it could continue to obtain funding by selling corporate bonds in the same manner, albeit without federal subsidy.

Uncertainty about the anticipated revenues in the event of success is a major factor in the present assessment of space manufacturing as "too risky."

I hope these suggestions will prove helpful. I am most concerned that, whatever institutional arrangement results from these considerations, it should be designed for success from the very start. I further hope that increasing the benefits of success will be considered a more desirable way to reduce risks than merely decreasing the pain of failure. Pain is valuable, and should not always be anesthetized. Positive incentives, I believe, will insure the success of space industrialization.

Announcements:

Air and Space Museum Marks 40 Years of Jet Aviation

Famous pioneers of the jet age will meet for the first time at a day-long symposium on Oct. 26 at the Smithsonian's National Air and Space Museum.

The symposium will mark 40 years of jet aviation. Participants include:

- Brigadier General Charles "Chuck" Yeager, the first person to fly faster than the speed of sound;
- Air Commodore Sir Frank Whittle, first to successfully operate a turbojet engine;
- Hans J.P. von Ohain, developer of the engine for the first jet aircraft;
- Najeeb E. Halaby, former head of the Federal Aviation Administration and Pan American World Airways; and
- John E. Steiner, "father of the Boeing 727."

Forty years ago, the first aircraft powered by the jet thrust of a gas turbine engine, the Heinkel He. 178, lifted off the ground at Marienehe Airfield in Germany. That historic flight ushered in a new era—the jet age. Each speaker at the symposium played a significant role in the development, production and expansion of jet aviation.

A well-illustrated book containing the lectures and five additional articles will be published Oct. 26 by the Smithsonian Institution press. Edited by Walter J. Boyne and Donald S. Lopez of the National Air and Space Museum, the book spans the history of the jet age as recorded by the people who made it happen. Other articles are by Anselm Frantz, who first developed the axial flow jet engine, and Gerhard Neuman, who was responsible for many important engine developments.

The book also contains a significant collection of historical photographs, many never before published, as well as a comprehensive guide to bibliographic sources.

"Forty Years of Jet Aviation: A Symposium" will be held in the Museum's theater from 9:00 a.m.-4 p.m. Friday, Oct. 26. All lectures are free and open to the public.

Included in the collection of the National Air and Space Museum are the Bell XS-1 ("Glamorous Glennie"), the plane in which Yeager flew faster than the speed of sound; the Messerschmitt Me 262, the first operational jet fighter; and the Bell XP-59A, the first American turbojet airplane to fly.

Beginning Sept. 4, the Air and Space Museum is open seven days a week from 10:00 a.m.-5:30 p.m.

Antioch Lecture Series

A lecture series on space exploration and space colonies is being held this Fall at Antioch College in Yellow Springs, Ohio. The lecture series features Princeton Professor of Physics Gerard K. O'Neill (author of **The High Frontier—Human Colonies in Space**), Timothy Leary, and Peter Vajk (pronounced "vike"), scientist and author of **Doomsday Has Been Canceled**. Other speakers include Barbara Marx Hubbard, co-founder of the Committee for the Future; Dr. Stephen Cheston, president of the Institute for the Social Science Study of Space in Washington, DC, and publisher of the journal "The Space Humanization Series," the Honorable Edward Finch, Jr., chairman, Aerospace Law Committee of the American Bar Association and former Special Ambassador to the United Nations; and Michael Michaud, author, lecturer, and an employee of the Department of State.

Antioch College is the school that pioneered the work/study program, coed dormitory living, social activist studies and written evaluations in place of letter grades. Fall 1979 marks the first time in its long history that Antioch will offer a course and lecture series on the social, political and scientific implications of space exploration.

Already with a place on the space shuttle reserved for experiments, Antioch is developing an interdisciplinary program in space studies geared especially for students of the social sciences and humanities. Faculty from all academic disciplines will be participating in the class.

Antioch College is also developing for its students space-related jobs with companies and institutions around the country. The work/study program of Antioch requires students to work as well as study in order to graduate. These space related jobs will supplement the hundreds of existing employment opportunities already open to Antioch students.

For further information contact Harrell Graham, Antioch College, Yellow Springs, Ohio 45387 (513) 767-7177.

Errata

No Moon Glass Workshop Summaries— In the August 1979 **L-5 News**, an article entitled "Moon Glass" appeared in the announcements section erroneously advertising a workshop summary. There are **no** summaries available for the "Glass and Ceramics Industry in Space Based on Lunar Materials" workshop held at the Lunar and Planetary Institute.

New Button Available

© JULY 4, 1979

Jon Alexandr

Jon Alexandr, designer of the "Conserve Earth—Colonize Space" bumper sticker, has now produced a button with a similar message designed to prod people out of their normal mode of thinking.

The buttons may be purchased by mail in quantities of 15 (for $5.00) or 33 (for $10.00) from the Bay Area Chapter of the L-5 Society. Orders are particularly invited from other L-5 Chapters and should be sent to:

Bay Area Chapter L-5
3144 Henderson Drive
Richmond, CA 94806

LIS

If you voted in the LIS election but didn't get the mailing of July 20, please write in to the L-5 Society and let us know. We will reinstate you on the LIS mailing list.

Government Publications

The following books are issued by:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Skylab, Our First Space Station

The vast accomplishments of Skylab are almost too profound to grasp. This publication, through its many color photographs, follows the three piloted Skylab missions from launch to reentry, providing key insights into the human as well as the technical side of the program's triumphs.

Skylab established a broad base of factual data on which to base the design of future space systems and the planning of future operations in space. This volume narrates that episode of America's history. 1977. 164 p. il. $7.00. To order, write to:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

"Careers in Space" Conference Planned

"Where do I sign up?" is a favorite question of would-be space pioneers. Today, however there's no place where you can just walk in and sign up for a job in space. But there's hope on the horizon. With the US space shuttle about to begin regular Earth-to-orbit service, with the Soviet Salyut-6 space station's cosmonauts conducting space manufacturing experiments, the European Space Agency Spacelab nearly completed and a Japanese space shuttle on the drawing boards, experts are predicting hundreds to thousands of jobs in space will open up in the next 10-20 years, with many more space-related jobs on the ground.

What will these jobs be and how do we get in line for them? The L-5 Society and the American Astronautical Society are organizing a three day conference, "Careers in Space" to be held in San

Francisco in late June 1980 to help answer that question.

Topics to be covered will include what careers will be opening up, how and where to train for these careers, and — most important — what we can do to push the New Space Program which is going to create these jobs in orbit.

This conference will provide low cost housing and food, so you won't have to be a fancy executive in order to attend. We plan tutorial sessions to provide you with a basic background in several career areas so you can better choose your occupation of the future. Evenings will be reserved for fun!

Let us know what you'd like to get out of this conference. Please send the questionnaire below and any additional comments to:

Careers in Space
c/o L-5 Society
1620 N. Park
Tucson, AZ 85719

The careers in space which interest me are:

__________ space transportation
__________ space station/habitat design and construction
__________ power satellites
__________ communications satellites
__________ remote sensing
__________ entertainment
__________ food preparation
__________ agriculture
__________ other life support
__________ materials processing
__________ mining of Moon and asteroids
__________ computers
__________ law
__________ management
__________ mental health
__________ medicine
__________ business
__________ other (please list) ____

____

____

I would like to enjoy the following evening conference activities:

__________ music (what kind?) ____
__________ dance (what kind?) ____
__________ exciting lecturers (who?) ____

____

__________ other (please list) ____

____

I want to push the New Space Program by learning how to:

__________ organize a local L-5 chapter
__________ conduct community education programs with displays, information booths, lectures, film festivals, etc.
__________ influence the media
__________ influence politicians
__________ develop private enterprise space activities
__________ initiate a space education program at my local college or high school
__________ other (please list) ____

____

My major areas of interest are ____

____

____

My occupation is ____

My level of education is ____

Inside the L-5 Society

The High Frontier Trading Post

The High Frontier Trading Post is an L-5 member service; each noncommercial member is entitled to one free ad per year, not exceeding 40 words in length. Extra or longer ads will be charged at a rate of $ .20 per word (or $4.30 per square inch). Please allow 3-4 months for your ad to appear. All ads are subject to editorial review.

Call for Papers: If you presented a paper at AIAA, ASCE, SPS or other student chapter meetings and would like to be included in Space Colonies: An Annotated Bibliography, send an abstract to Loompanics, PO Box 264, Mason, MI 48854.

Cascadia Futuria: A New Chapter

Futurists in Portland, Oregon, met September 8 to form Cascadia Futuria, an "Umbrella Organization" to promote thought of the future and futurist activities. The first activity was to form a local L-5 Society chapter and elect officers. Future meetings will be held in Room "E" at the Multnomah County Central Library, Portland, Oregon, 14:00 on October 6, November 3, and December 1. Also being organized is an L-5 display for the ORYCON Science Fiction Convention to be held in Portland, November 9-11.

Persons wishing further information can contact Bryce Walden, 13933 SE Mall, Portland, OR 97236, or call the LightLine (503) 761-8768 and leave a message, or contact the local L-5 chapter president, Susan A. Word, 7144 SW Oleson Road #75, Portland, OR 97223, (503) 246-4432.

Jody Rawley: We would like to send you complimentary copies of the September **News** and thanks for your article. But we have no record of your address! Please write in to the main office.—JA

Georgia L-5 Cosponsoring "Issues for Tomorrow"

The Georgia affiliation of the L-5 Society is kicking off Fall with cosponsoring "Issues for Tomorrow," the southeastern regional conference of the World Future Society, being held at the Georgia State University Urban Life Center in Atlanta (announced in August **L-5 News**).

Barbara Marx Hubbard, L-5 Board of Directors member, will give a plenary address on Friday morning, October 12, the first day of the two-day conference. Konrad Dannenberg, L-5 Board member, will lead an afternoon panel shared by Richard Brown of NASA-MFSC in Huntsville, Gerald Driggers of the Southern Research Institute and Jesco Von Puttkamer of NASA Headquarters Advanced Planning. They will discuss "Space in the Eighties—and Beyond: The NASA Program and Space Industrialization" and will describe the latest program of research development, and applications of the space shuttle to the extent of NASA's planning horizon.

Bill Gardiner, President of the Georgia Tech Chapter L-5, will lead a panel shared by Jack Spurlock and John Carder, Associate Director and Senior Research Scientist respectively of Georgia Tech's Applied Sciences Laboratory; Garry Noyes, of the Environmental Engineering Sciences Department of the University of Florida; and Ina Jane Wundram, of the Anthropology Department of Georgia State University. They will discuss "Space Settlements: Reconstruction Spaceship Earth," putting a current focus on the prospects and problems of constructing and maintaining closed ecological life support systems (CELSS) in the space environment.

Although the standard conference fee increased on September 13 to $40, L-5 Society members registering after September 13 may still pay the conference fee of $30, spouse fee of $15, and student fee of $5 by mentioning **L-5 News** with their remittance to:

Division of Public Service
Registration Office
Georgia State University
University Plaza
Atlanta, Ga. 30303

For more information contact Bill Gardiner at (404) 873-6159 or 762-1986.

Georgia Tech Chapter members promote L-5 alongside the doomed space shuttle Enterprise. The Enterprise was at a stop-off in Atlanta on its way to California to be scrapped.

To L-5 Members:

Some questions have been raised about the functions and overall effectiveness of the L-5 Society local chapters. It seems that after the initial steps of organizing a local chapter have been overcome, the members are at a loss as to what to do next. Many chapters seem to be content to have meetings among themselves to discuss their individual views concerning space humanization. Does this really serve the purposes of the society?

The L-5 Society is right now at a turning point. In order to attract more members, the quality of the **L-5 News** needs to be upgraded. In order to fund upgrading the **L-5 News**, L-5 membership must increase. This is where the help of local chapters is needed most. L-5 members tend to assume that the general public is not lacking knowledge of the space program, but merely the support of it. Having been a member of the general public in the not too distant past, I cannot agree.

The logistics are simple. One cannot support that of which one has no knowledge. This is something L-5 local chapters can do. First, arm yourselves! Read up on space colonies so you can answer questions. Organize yourselves; have headquarters send you some promotional materials, then set up an information booth in a conspicuous spot (a shopping mall, etc.). Your presence will arouse the curiosity of passers-by. Tell them what you and L-5 are all about.

The present circulation of the **L-5 News** is close to 3600 copies per month. If the number of our members were raised to 4600 (that's one new member for every three current members), the **L-5 News** could start a program to promote newsstand sales. Each issue sold on the newsstands from that point would convert to a reduction of production costs. Once circulation is over 10,000 per month, production costs would drop considerably. (This means the money could be better spent elsewhere.)

One of the major complaints about the **L-5 News** is the habitual lateness of delivery to certain parts of the country. An increase in circulation would help alleviate this problem also. If there are ten or more members who receive their **L-5 News** at the same Post Office, the magazines can be bundled together and sent directly to that office. If, on the other hand, there are only a few members in the region, the mail is sent through normal sorting procedures, and we all know how long that can take.

Humanization is the key word, for people will colonize space. The L-5 Society needs people for its support. L-5 national is constantly seeking ways to better serve its members. In order to provide more services, more members are needed. In order to prosper, in order to be more effective in not only promoting but reaching the goal of the humanization of space, the L-5 Society must grow.

Randy Clamons,
Administrator

L-5 Society Revenue and Expense Statement
July 1, 1979 - August 31, 1979

Revenue		Expenses	
Memberships	14,908.42	General Office	5,879.20
Donations - LIS	493.50	**L-5 News**	7,108.58
Donations - General	422.65	Legislative Information	982.30
Merchandise Sales	1,180.26	Contract Services	1,263.14
Contract Services	1,963.39	Promotion	3,772.32
Miscellaneous	374.70	Merchandise Expense	191.53
Total Revenue	19,342.92	Total Expenses	19, 197.07
	Excess Revenue Over Expense	145.85	

Give this membership form to a friend!

L-5 Society Membership Form (please type or print)

NAME: ____________________

ADDRESS: ____________________

CITY/STATE/ZIP: ____________________

AFFILIATION/TITLE OR POSITION ____________________
(OPTIONAL)

I am____ am not ____ interested in being active locally. Phone (optional) ____________________

____ Please enroll me as a member of L-5 Society ($20 per year regular, $15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of $12/year included in membership dues).

L-5 Society members who sign up for the Space Legislation Hot Line option receive frequent first class mailings on the actions of Congress and the President which affect the space shuttle, space colonies, solar power satellites, space exploration and other space projects.

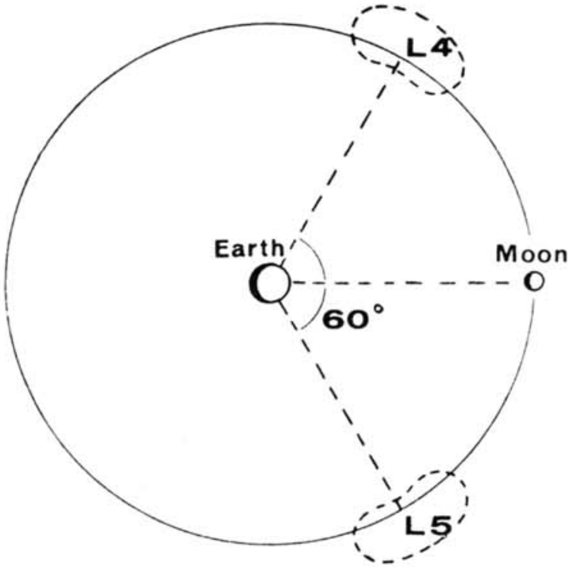
____ Sign me up for the Space Legislation Hot Line.

L-5: A Place in Space

by T.A. Heppenheimer

L-5 is the fifth Lagrangian Libration point. But what are libration points? They are locations where a spacecraft may be placed so as always to remain in the same position with respect to the Earth and the Moon.

The French mathematician, Lagrange, in 1772, showed that there are five such points. Three of them lie on a line connecting the Earth and Moon; these are L-1, L-2, and L-3. They are unstable; a body placed there and moved slightly will tend to move away, though it will not usually crash directly into the Earth or Moon. The other two are L-4 and L-5. They lie at equal distance from Earth and Moon, in the Moon's orbit, thus forming equilateral triangles with Earth and Moon. These points are stable. It is a curious fact that they are stable because the Moon is only 0.01215 times the total mass of Earth and Moon together. If the Moon were greater that 0.03852 times the total mass, L-4 and L-5 would be unstable.



The situation, however, is even more complex than this. The Sun is in the picture and it disturbs the orbits of spacecraft and colonies. It turns out (from an extremely messy calculation done only in 1968) that with the Sun in the picture, a colony should be placed not directly at L-4 or L-5, but rather in an orbit around one of these points. The orbit keeps the colony about 90,000 miles from its central libration point.

In the colonization project, the colonies may be located in the vicinity of L-4 or L-5. L-2, located behind the Moon, is the site of a catcher vehicle, which collects mass shot up from the Moon by the mass-driver. The "2:1 resonant orbit" is also a solution of the restricted four-body problem (Earth, Moon, Sun and satellite), as are the kidney-shaped orbits around L-4 and L-5. The orbit is roseate-like, and can be thought of as an elliptical orbit which precesses around the Earth very rapidly, with a satellite in such an orbit returning to the same location relative to the Earth and the Moon every two months. Such an orbit is relatively stable, requiring nominal station-keeping, and has the advantage of a relatively small "delta-vee" to transfer completed power satellites from a space manufacturing facility to geosynchronous or lower orbits. For this reason some researchers believe that the 2:1 resonant orbit will be the site of the first space manufacturing cities, rather than L-4 or L-5.

But the issue that has people excited is not what orbit will be chosen but what could be done there. Space industries in one of these orbits could manufacture solar power satellites (SPS) from lunar or asteroidal resources. Each SPS could deliver twice as much low cost, environmentally safe energy to Earth, via microwaves, as the Grand Coulee Dam, and forty-five of them could meet the total present electrical power needs of the U.S.

This activity would create tens of thousands of jobs in space and on Earth within as short a time as 15 years.

The **L-5 News** once proposed that we disband in a mass meeting at L-5, but we're not particular — the 2:1 resonant orbit would do as well. Getting tens of thousands of us living and working somewhere in space is our goal.

Spread the Word

We of the L-5 Society of New Bern have found a very effective method for spreading the news of L-5. This method involves only L-5 buttons and membership flyers.

The idea is to wear your L-5 button no matter where you go and carry along some membership flyers (the ones which tell what L-5 is) in your car. Wearing the button is an automatic attention-getter. The first thing people will ask is what is L-5? Explain briefly and ask if they would like some literature on the subject; that you just happen to have some in your car. If they want to see the literature, give them one of the membership flyers. Even if they don't, they have at least heard of L-5. Some may even become interested enough to attend one of your meetings.

The beautiful thing about this method is that it does not force your ideas on someone else. We have sometimes faced open criticism and hostility when trying to volunteer information. When they pop the question and then differ from your opinion, they tend to be more polite. We are not trying to discourage other ways of achieving L-5 goals, but rather encouraging a way which requires no planning, costs almost nill and brings a large amount of people in contact with the L-5 dream.

Danny Hill
L-5 Society of New Bern

Letters

By innuendo, not worthy of a scholarly publication, the "News Brief" appearing on page 15 of the September L-5 edition, must logically conjure up in the minds of your readership some imaginary point counterpoint of opposing views on the draft Moon Treaty between myself and S. Neil Hosenball, the NASA General Counsel. In his federal capacity, Mr. Hosenball is depicted as "countering" concerns about the Moon Treaty registered by Leigh Ratiner, while I am portrayed, in my capacity as the NASA-Ames Chief Counsel, as "retorting" against, and dissenting from, the views of my agency supervisor.

Let me clear the air at the outset by stating that as a lawyer, as a private individual, and as an independent researcher, I consider the draft Moon Treaty unsound as a legal instrument. But the disagreements which I have expressed, and continue to express, about the draft Moon Treaty and its possible future adverse impact upon human rights and fundamental freedoms in space arise from conclusions set forth in prior research of mine published by U.C. Berkeley and Columbia University, long before any consensus existed at the U.N. Space Committee on a single draft Moon Treaty text.

In defending my published works as a legal scholar—and not as a federal official espousing a position—I have always taken measures to exclude the superfluous fact of my federal employment when responding to questions. Consequently, when Carolyn Henson phoned me a few weeks ago and asked whether the views and conclusions emanating from my research were for attribution, I indicated then, as I always will, that they certainly are. I did not entertain the notion, however, that the **L-5 News** would rework my comments to appear as if they emanated from some imaginary policy debate with my NASA supervisor. For the record, I have never, at any time, had discussions with Mr. Hosenball concerning the Moon Treaty, nor do I have any involvement, in my NASA employment, with any matter before the United Nations Space Committee.

In the course of our conversation, and in all of our prior contacts, there was ample notice that my views and conclusions of law were offered entirely in my private capacity and not as a federal official. The Columbia article that I sent in, as a result of our conversation, makes no reference to my NASA employment. All letters written by me to the L-5 Society appear on individual stationery. Moreover, specific views of mine registered in the past and published in the **L-5 News**, do not in any way advert to the fact of my federal employment (see June 1978 edition, pp. 12-14). So I think that my sentiments on this point had to be clearly known.

In closing, there remains nothing further to be done except for you to print this letter to allay any misimpressions entertained by your readers, and for me to apologize to Neil Hosenball—not because he is my NASA supervisor but rather because he has been a trusted colleague and friend of many years—for the "cheap shot" appearing in your September edition.

J. Henry Glazer, J.S.D.
San Francisco, CA

In response to Ken McCormick's article "High Frontier Politics" in the June issue of the **L-5 News**, I would like to state that while SPS construction is certainly the most attractive plan that will lead to the permanent human habitation of space, it is important not to depend on power satellites exclusively as a justification for this goal. In terms of services and industries that can be conducted in space, SPS is one of many. It is true that SPS does have the greatest potential for getting humanity into space on a large scale, however the concept also has the highest risk. While virtually all people agree that SPS is technically feasible, many SPS supporters state that there are questions of economic practicality still to be answered. This is why a vigorous program of research, development and evaluation, which Congressman Ronnie Flippo and AIAA advocate, must be conducted before any commitment to SPS can be made. The L-5 Society should take an active role to ensure that the power satellite concept gets the research funds that it deserves, but I would be disappointed to see L-5 close its doors if continued SPS research results in negative conclusions.

In order to maximize the probability of achieving human independence from Earth, it is necessary to promote and encourage the development of all profitable space activities. In other words: don't put all of your eggs in the SPS basket. Although orbital manufacturing may have from 1/4 to 1/10 the profit potential of SPS, it is still an attractive option in the event that SPS proves to be impractical.

With regards to other large-scale space industries possibly comparable to SPS, Brian O'Leary of Princeton University has stated that large orbital agricultural facilities could become a major space industry in the near future. And there is always the possibility of lunar and asteroidal mining and orbital refining as a profitable venture in itself.

William C. Rudow
Rockport, MA

Who is working on the obvious relationship between offshore oil-field construction work and space work?

The day-to-day work of a saturation diving team is very nearly the equivalent of the work of a space work crew. A sat team lives in a chamber complex for a period of some weeks. The team remains pressurized at the working depth pressure. Teams of two divers at a time are ferried to the work at depth in a bell. These divers lock out of the bell, one at a time, and work about 4 to 5 hours apiece.

Their shift completed, they are ferried back to the surface. The bell is mated to the chamber complex. The first two divers return to the chamber, two more enter the bell. These two divers now go to work their shift.

Work continues in shifts in this manner 24 hours a day until the job is complete. Generally a team living in the sat complex consists of three two-person teams of working divers, a "sat tender" to care for equipment, and possibly a medic. Sat technicians work outside on deck, monitoring life-support, serving meals, etc.

When large-scale projects are constructed in space, the work will probably very much resemble the activity of a sat job.

If you know of other people who are interested in or are working on this connection, please write to me.

Charles S. Upp
SR Box 11385
La Quinta, CA 92253

Last February or so, I renewed my membership with L-5 until next April (1980). I also included a rather lengthy note in which I made some comments and suggestions concerning the Society. The only response I received was simply a membership card in an envelope. If you don't feel that my comments are appropriate, fine; but I think that I deserve at least an acknowledgement of my letter. A simple letter to me would not require much effort on your part, and it might retain a few memberships; no one likes to be snubbed.

Richard Schultz
Seabrook, TX

L-5 members, help! People such as this often write in—heaps of these letters every day. Any volunteers to help answer mail?—CH

I must express my concern over the fact that certain L-5 members seem to be jumping on the anti-nuclear bandwagon. Nuclear fission is still the safest and cheapest large-scale energy conversion system, Harrisburg notwithstanding, and those technical problems it undoubtedly has are likely to be far more tractable than those we will run into with solar power satellites (SPS). As to social constraints . . . well, SPS is as vulnerable to phony statistics and scare headlines as nuclear fission. Our emphasis should be in developing SPS as a *cheaper* energy source than any competing one: technically better, not just socially more acceptable. Besides, an energy-rich society is far more likely to invest in space than an artificially energy poor one.

John R. Aynesworth
Sherman, TX

L5 NEWS

November 1979

Lightsail Update - Eric Drexler

L-5 Sparks Moon Treaty Opposition

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 4 NUMBER 11 NOVEMBER 1979

In this issue:

1 **Lightsail Update** *by Eric Drexler. A better name! Favorable tech review. And answers to a member's critique.*

3 **Free Enterprise and the Proposed Moon Treaty, Part II** *Concluding Art Dula's appraisal of a critical issue for all space inhabitants.*

7 **L-5 Board of Directors Member, Hon. Edward R. Finch Jr., Speaks Out in Favor of the Moon Treaty.** *The other side of the story.*

8 **L-5 Speaks to DOE: There's an SPS in Our Future** *by Annita Harlan. Results from the L-5 questionnaire.*

9 **Shuttle Express.** *Ed Bas tells how much it will cost to use the Space Shuttle "bus."*

10 **NASA Vindicated.** *Carolyn Henson previews a Carter committee report that affirms the agency's competency.*

Studying Flares From Space. *"Windows" on the Sun's spectacular outbursts will come from the mission of "Solar Max."*

12 **The L-What Society?** *A member argues for visibility and political activism.*

L-5 Sparks Moon Treaty Opposition *by Carolyn Henson. A report of political actions; the Society puts its money where its mouth is.*

13 **Space Colonization in the Classroom** *by Lawrence C. Wolken. How to teach our children that space is in their future.*

14 **Book Review.** *Carolyn Henson reviews Jerry Grey's "insider's" tale of the development of the Space Shuttle.*

Reading News

15 **News Briefs**

16 **Announcements**

Trading Post

Inside L-5

18 **Letters**

Cover: The Lightsail artwork by Carolyn Henson from a photograph by Steve Bell from a model by Keith Henson from a concept by Eric Drexler. How's that for teamwork?

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Annita Harlan,
Carolyn Henson,
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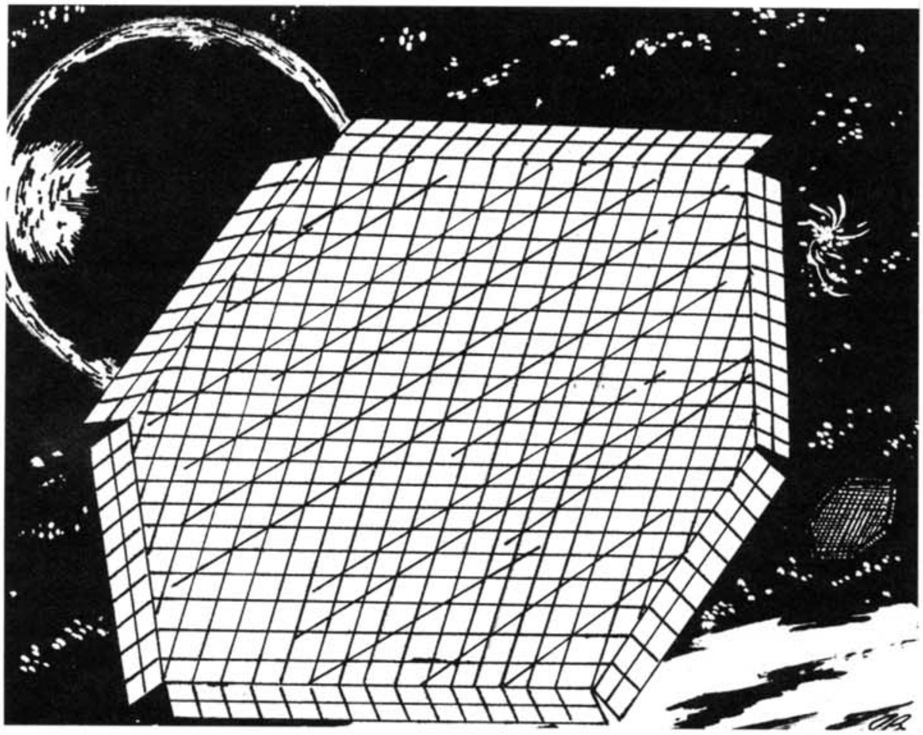
Lightsail Update

by Eric Drexler


Artwork by James Babcock

After almost three years of work, the lightsail (high performance solar sail) concept is beginning to receive widespread attention. In June, Dr. Arthur Kantrowitz invited me to give a presentation to a NASA innovation study group which included NASA Administrator Dr. Robert Frosch. It was well received and led to invitations to speak at the Aerospace Corporation and Jet Propulsion Laboratory (JPL). NASA now plans a formal review of the lightsail concept.

In these talks, and in further talks at RAND and Boeing, no threats to concept feasibility were uncovered. People were interested and took the concept seriously. (Having samples of the sail material to pass around the audience probably helped.) At JPL, people with experience in designing spacecraft (including deployable solar sails) expressed confidence that thin film materials were usable as sail materials. They felt that lightsail development costs would almost certainly fall below the one billion dollar level quoted on one of my slides.

This is less than 1/6 the cost of Shuttle development. An asteroid (or Deimos) dirt scooper should be pretty cheap. Since a few sails and a scooper could recover non-terrestrial materials, it seems that the cost barrier to space mining has dropped by a factor of ten or more. Further study seems called for.

Why "lightsails"?

The first English language reference to the use of light pressure for space propulsion (C. Wiley, **Astounding Science Fiction**, May 1951) referred to the device as "sail" and proposed using thin metal films, manufactured in space, for the reflector. Later, when spaceflight became a reality, attention shifted to deployable plastic film sails and the name "solar sail" was adopted.

There are a number of reasons for applying the name "lightsails" to space-manufactured, thin film sails. When compared to conventional sail concepts, they employ different structures and materials; they pose greater technical challenges, and they offer 20 to 80 times the acceleration. This alone would make the old name a little misleading. Further, the name "solar sail" leads to confusing conversations ("How efficient are these thin film solar cells?" or "I've got a cousin who works in solar sales"). Then of course solar *sails* use the solar wind...don't they? Finally, once it is made clear that the *sail* uses *light*, the adjective "solar" fails to suggest that sails can use infrared radiation and reflected light from planets, or that they can (someday) be boosted to interstellar speeds with huge lasers.

Since space-manufactured, thin film sails both use light and are light, "lightsail" seems appropriate. It is a distinctive name for a distinct concept, and it avoids the confusions of pronunciation and meaning that come with "solar sail." Finally, it sounds nice, and my mother likes it.

...lightsail development costs would almost certainly fall below the one billion dollar level...This is less than 1/6 the cost of Shuttle development.

Crawford Letter

The following letter from Dick Crawford raised some interesting questions:

"I have a few comments about the two solar sails articles in the May 1979 **L-5 News** ("Breakthrough" by Carolyn Henson and "High Performance Solar Sail Concept" by Eric Drexler):

"(1) The asteroid mining scheme depicted in Mrs. Henson's article looks great, except for one picky little detail. Tethering the sail to the asteroid as shown would be feasible only if the body is nonrotating (there aren't any such known) or if the point of attachment is somewhere near the axis of rotation on the night side. And that presents a problem for stays of more than a few months. Hence the loading phase should be as short as possible.

"(2) Mr. Drexler's idea of providing holes in the backing foil to permit the escape of gases from under the sail foil disturbs me. In the first place, any hole in the backing assures a hole in the sail foil (the evaporated film won't bridge gaps). I can't believe that a sail foil with holes in it would be stronger than one without holes.

"In the second place, I can't see the need for such holes. Their purpose seems to be to prevent any gas buildup between the two metallic foils that would rupture the thin sail foil. The easy way to control that is with temperature gradients. Just keep the whole sandwich cold enough to prevent sublimation until you want the foils to separate, and then apply heat (sunlight?) starting from one edge. The sublimed material (of which there need not be much, anyway) would escape gradually, under perfect control, and gently waft the sail foil away.

"(3) The idea of cutting the sail foil segments while they are still attached to the backing foil seems to me needlessly complicated. I have trouble visualizing a blade that would cut through the one without marring the other. The easy way would be to deposit the sail foil segments to the right size and shape by masking, and eliminate the need for cutting.

"(4) I also worry about the strength of the sail foil. In my experience (admittedly limited and out of date) deposited metal films tend to be very brittle when detached from the backing. We solved this for our application by depositing reflective coatings on ultrathin plastic films. Might it not be possible to blow a big bubble of some low-vapor-pressure monomer that would be activated by sunlight to polymerize into a tough plastic? One could even imagine doing this inside a mesh of fine wires that would become part of the bubble, providing readymade attachment sites for the control and load-bearing lines.

"(5) Mr. Drexler's proposal calls for a vapor-deposition power supply. Making the sail in one unit of thin plastic allows us to do the vapor deposition all at once. For this we could consider a chemical source of aluminum vapor, the thermite reaction, which would be much lighter and more positive.

"Needless to say, there may be many hidden flaws in my ideas. I have invested almost no time in detailed calculations and engineering analysis. I would appreciate hearing from other L-5 members whether they can see any obvious booby traps I have overlooked, or whether they have any better ideas. Personally, I mistrust mechanical devices that must operate unattended for years and prefer simpler, one-shot processes. For one thing, they are usually cheap enough that if one of them doesn't work you can just send up another."

Dick Crawford
Walnut Creek, CA

Crawford response:

Mr. Crawford raises many interesting issues in solar sail design, fabrication, and use. Most have not been raised in print. At the risk of turning the **L-5 News** into a journal of lightsail technology, I would like to discuss them at some length.

New concepts like the lightsail generally benefit from a widespread exchange of ideas. The particular concept that I finally laid out is conservative in the sense of being comparatively easy to design with the information available to me. It is but one of many approaches to lightsail design and fabrication (you should see my heap of discarded ideas!).

(1) It is true that a tether from a sail to an asteroid must be attached to the asteroid at a point near the axis of rotation on the night side. However, if the tether is of reasonable length, the exact point of attachment isn't too critical. Still, as the seasons change on the asteroid, a tethered sail would run into trouble. However, since scoopers running at only 1/10 kg/sec can collect a 100 ton load in less than two weeks, this shouldn't pose a serious problem.

The tether can be eliminated if the sail can be brought by the asteroid repeatedly. The problem is that light pressure can't be completely shut off, so the sail always drifts with respect to a body in free fall. Gravity could keep a sail near a large asteroid or a moon of Mars. With patience (or an auxiliary propulsion system) a sail can make repeated flybys of any asteroid. In all these cases, the sail would drop off a scooper on one pass, let the scooper fill a bag with dirt and chuck it off into space, then fly back to perform an automatic docking with the bag (a la Progress).

The particular concept that I finally laid out...is but one of the many approaches to lightsail design and fabrication...

(2) Since the average stress in the film material is less than 1% of its fracture stress, strength is not of the essence. Tears, not fracture, are the real threat, and properly placed holes can block tears. For this reason (and to permit the escape of subliming vapor during fabrication) a pattern of cuts seems desirable.

The idea of peeling the film with a single wave of sublimation is interesting, and might work out. I selected a process involving many small pockets of sublimation to allow high production rates in a small device operating near thermodynamic equilibrium in the sublimation chamber. A potential problem with sublimation far from the equilibrium pressure is premature separation and blistering, causing damage to the film. Such problems might not arise, particularly if steep enough thermal gradients can be applied.

(3) Here's an idea for cutting the film without marring the backing foil. The film is less than 1/10 micron thick, and is supported on a micron or so of soft organic material. Plastic cutting blades should suffice to produce a line of damage when pressed firmly against the film. The backing foil is perhaps 25 microns thick. Make it of a hard alloy, or surface it with a hard alloy. Where it is pressed against the plastic blades, it can be supported by stretching it over a smooth steel roller. Such a well-supported, hard-surfaced foil should escape damage under these conditions. If not, there are other approaches to cutting the film.

Masking the substrate during film deposition can create holes, separation lines, or bands of thicker material in the film. This flexibility could prove very useful, particularly in squeezing the last bit of performance out of the sail. The masks would add to the number of moving parts in the device, however, and would require a subsystem to clean deposited metal from them.

(4 and 5) As was mentioned, the film's strength is high, but tears are a threat. My experience with handling aluminum films in the proposed thickness range makes me respect their fragility, but they seem rugged enough for the lightsail application (see the comments at JPL, cited above). Space-manufactured plastic films are worth examining, but face problems in achieving adequate strength, formability, and resistance to ultraviolet light all in the same material. Previous designers of plastic film sails have been forced to use fairly thick metal films to protect even thicker plastic films from ultraviolet light.

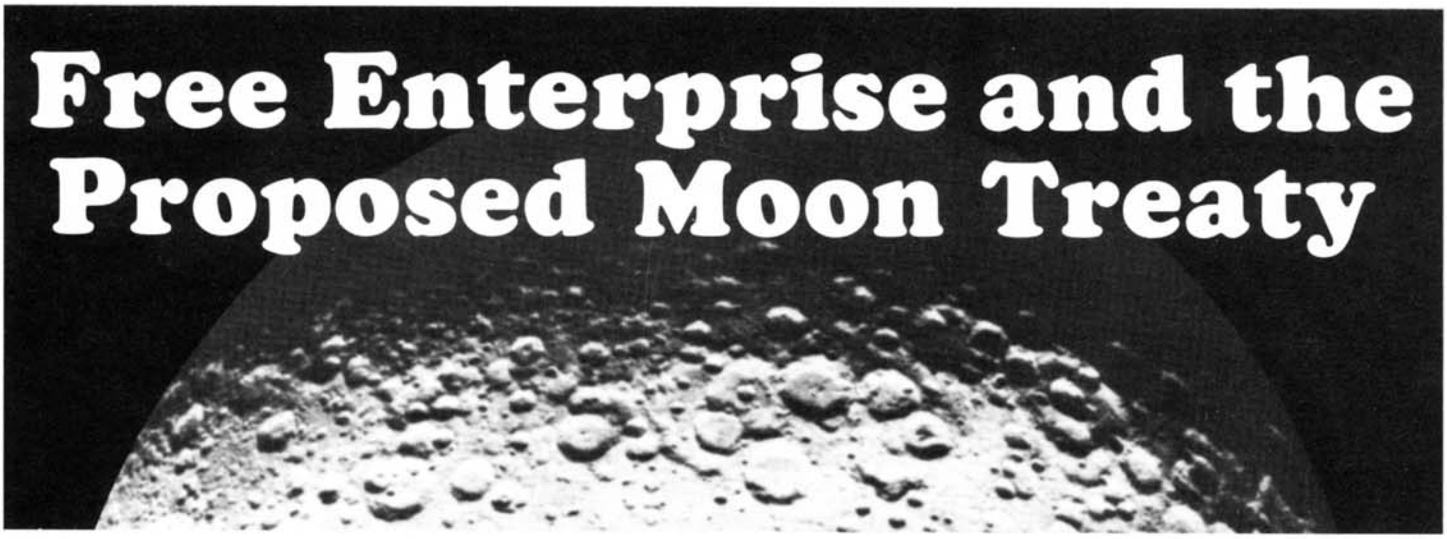
If a monolithic approach to lightsail fabrication proves feasible, a device using the thermite reaction would certainly heat a lot of aluminum in a hurry. While simpler than solar cell and electron beam vapor sources, it wouldn't be lighter for very long. The proposed film fabrication device could make its own mass in film in about a year, while a thermite reaction would leave a larger mass of waste aluminum oxide and metallic iron than of deposited aluminum. Although the mechanical system is more complicated, it is also more efficient, more controlled, and more flexible. Once the production bugs are worked out, this should lead to lower cost, higher performance, sails.

The mechanical system need not work unattended. If it is built from plug-in, replaceable pieces, a remotely operated manipulator could do regular maintenance. Once a high-orbit space station is in place, maintenance will be duck soup.

It will be many years before the last word is in on optimal lightsail design. In the meantime, a sensible development program would examine many options in more depth.

Eric Drexler is currently a graduate student at the Massachusetts Institute of Technology where he is developing the high performance solar sail as the key to inexpensive mining of the asteroids. He founded the MIT Space Habitation Study Group in January 1975. (It may be the oldest pro-space habitats citizen's group in existence.)

Free Enterprise and the Proposed Moon Treaty



Part II

by Art Dula, aerospace/patent lawyer in private practice.

Pro—The Moon Treaty as a Compromise that Allows Scientific Research

Proponents maintain that the Moon Treaty is a working compromise with the U.S.S.R. and the Third World. They stress that the Moon Treaty does not impose a moratorium on either space exploration or experimental use of space resources, pending establishment of an international legal regime to control exploitation of those resources.

This compromise is clearly a concession for the Soviet Union and the Third World, neither of which has the technical capability to exploit space resources, and both of which are immensely fearful of free enterprise. As late as 1974 a leading Soviet international space law expert, A.S. Piradov, used fear of free enterprise and "the intentions of big businessmen" to justify Soviet Moon Treaty provisions forbidding the establishment of any type of property rights in space resources.

"Such detailed enumeration of the legal and physical persons which could potentially claim establishment of a property right over the Moon, is, in our opinion, completely justified. The problem could be especially acute when the exploitation of natural resources has begun on the Moon or in its depths. *The intention of big businessmen in relation to the future use of the Earth's natural satellite is too well known not to take it into consideration.* (emphasis added)"

The compromise Moon Treaty specifically allows all states freedom to use space resources for purely academic purposes, such as the support of missions of scientific inquiry and research. If the U.S.S.R. and Third World are willing to accept U.S. unilateral statements interpreting the Moon Treaty as controlling the Treaty's meaning, then exploitation of space resources to support limited experimental and pilot plant operations may also be allowed prior to the time commercial exploitation of space resources becomes feasible and an international regime is established.

> ***"The intention of big businessmen in relation to the future use of the Earth's natural satellite is too well known not to take it into consideration."***
> ***—A.S. Piradov***

It may be suggested that investors could simply call whatever activities they decide to undertake in space or on the Moon "research and development," "experimentation," or "pilot plant operations." Unfortunately, this is not advisable because of differences in the legal consequences of experimental and commercial use. United States tax laws and regulations controlling investment in commercial operations differ greatly from the rules that apply to investment in experimental research or pilot plant operations. Generally, profits from the former are taxed and the latter deducted as expenses. The Internal Revenue Service and United States tax courts have proved themselves equal to the task of classifying investment as spending for legitimate research or commercial operations. If an operation consistently returns a *profit* to its owner, then it is "commercial" for the purpose of U.S. tax and investment law.

United States patent laws also differentiate between commercial and experimental purposes. Issuance of a valid U.S. patent is barred when an invention has been in public use or on sale within U.S. jurisdiction for over one year unless the use was for experimental purposes. Here again one of the touchstones distinguishing public use from experimental use is whether the owner of the invention makes a profit from its operation.

The Moon Treaty, if ratified, would be U.S. federal law and could be enforced by the federal courts. A group opposed to space industry, a foreign government, or even a foreign or domestic corporation that believed the U.S. or a U.S. company was violating the treaty could bring suit to obtain an injunction against the U.S. government, the company involved, or both to halt the violation. Thus, it is unlikely that a prudent investor would believe that calling profit-making exploitation of space resources "scientific investigations," could be any substantial protection against the legal risks associated with such deception.

It may also be suggested that U.S. industry may be willing, with or without government assistance, to invest in space research and development without making a profit. Actually, it is not necessary, desirable or even rational to assume that the initial exploitation of space resources by free enterprise will be so experimental that it will not make a profit. Economic reality dictates that any lunar venture undertaken by U.S. companies will be designed to make a profit from its very beginning. The hundreds of pounds of lunar samples returned to Earth by the Apollo program have provided qualitative and quantitative data on minerals from several parts of the Moon. These samples are chemically similar to well known Earth minerals. In fact, several commercial processes developed on Earth have already been successfully tested using simulated lunar materials. Because the expense of research and development in space will be vastly greater than the cost of similar works done on Earth, it is virtually inconceivable that a profit-making business would not choose to develop any needed processes for exploiting space resources on Earth. Lunar working experience and bootstrapping will improve and expand space-based processes, but even the very first private endeavor that exploits space resources can be expected to seek an immediate profit from the sale of goods derived from space resources.

Con—The Moon Treaty as a Moratorium on Enterprise Space Activities

The Moon Treaty is very close in spirit and critical language to the 1970 U.N. resolutions on the deep seabed. The following arguments against the treaty are the view of Leigh Ratiner, an expert on the history of the 1970 seabed resolution.

If the United States becomes a party to the Moon Treaty, the opportunities and prospects for private enterprise development of the resources of the Moon and other celestial bodies will be negligible if not non-existent. Specifically, the draft treaty would:

1. create a moratorium on *commercial* exploitation of the resources of the Moon and other celestial bodies, until a second, much more comprehensive treaty for regulating resource activities is concluded;

2. establish guiding principles for the negotiation of this second treaty which are completely antithetical to the commercial development of outer space resources by private enterprise; and

3. thereby give the Soviets or Third World countries tremendous political control over the timing and direction of expanding commercial uses of outer space, as well as the question of whether to permit such uses.

The Administration, particularly the negotiators of this draft treaty, argue that United States public statements to the effect that the treaty does not establish a moratorium negate the implicit moratorium in the treaty. Unfortunately, such a moratorium is now contemplated in the treaty and *underscored* by the U.S. Delegation's statements on the record. However, even if it is conceded that the U.S.'s unilateral statements control the treaty's meaning, the fact remains that no private enterprise, or even a government, is going to invest billions of dollars in developing new commercial applications of space technology if most of the world disputes its legal right to deploy and profit from that technology.

. . . (the treaty) would give the Soviets or Third World countries tremendous political control over the timing and direction of expanding commercial uses of outer space.

It may be asserted that the guiding principles set out in the treaty for constructing the legal regime to control exploitation of outer space resources are empty phrases to be given later meaning. The Moon Treaty, however, must be considered in the context of international law and practice. These phrases all have a very well-defined meaning and have been exhaustively elaborated in other treaty negotiations. Since the Soviet Union first introduced a draft text on the Moon in 1971, the politics of resource development in areas beyond the territorial borders of nations have changed dramatically. The Law of the Sea Conference has moved to near-completion of a treaty establishing a deep seabed resource regime based on virtually identical guiding principles to those contained in the Moon Treaty—for example, that such resources are the "common heritage of mankind," that their development should be orderly and rationally managed, and that the benefits (both financial and technological) should be equitably distributed.

Regardless of whether the Law of the Sea Treaty ever enters into force, the Third World has now developed a very sophisticated position on the content of an international resource regime that best serves its interests. Many informed observers will support the view that this detailed elaboration of these revolutionary new ideas reflect the international custom, practice and consensus as to how so-called "common property" resources are to be regulated, managed and developed.

The draft law of the sea treaty requires the collectivization of resource development through a global monopoly under the political control of a Third World dominated, General Assembly-type body. It restricts the rights of states and private enterprise to carry out activities to that initial period required to fully transfer their technology to the monopoly and fund its operations with their profits. Finally, it provides for international regulation of production levels and prices in order to discriminate in favor of developing countries.

The Antarctic Treaty Parties have also been trying to hammer out an agreement on that continent's mineral resources before the United Nations intervenes. The difficulties experienced in this negotiation are partly caused by the Parties' reluctance to follow the law of the sea precedent and the lack of any other alternative that will satisfy developing country expectations and thus prevent Third World intervention through the U.N. Since private industry knows that the ultimate Antarctic minerals regime may practically deny it access to the resources, just like the deep seabed regime does, no investments are now being made in exploring the potentially attractive offshore hydrocarbon deposits of Antarctica.

In summary, adoption of the Moon Treaty as the basis for negotiating a future resource regime for the Moon and other celestial bodies would borrow from these precedents. There are many other imaginative approaches which would enable the nations of the world to cooperate peacefully in expanding the commercial applications of outer space technology to resource exploration and development. Good examples already exist for commercial utilization of outer space, and there is no reason why the United States should permit outer space resource development to be thrust into a quagmire of political principles derived from the rhetoric of the new international economic order.

In view of the enormous capital and technology requirements contemplated for the future industrialization of outer space, political stability for investments will be absolutely critical. If this treaty is ratified by the United States, however, any commercial application of outer space technology which involves use of Moon or other celestial resources will be subject to the greatest insecurity imaginable. While the spillover effect for other commercial activities in outer space cannot be fully predicted, it may be very significant.

Specific Negative Implications of the Moon Treaty for Free Enterprise

Paragraph 5 of Article XI of the Moon Treaty obligates State Parties "to undertake to establish" a new regime for resource exploitation "as such exploitation is about to become feasible." One valid reading of this text is that the new regime *must* precede actual resource exploitation. The United States Delegation, however, has stated its interpretation that this provision "places no moratorium on the exploitation of the natural resources on celestial bodies." Yet Mr. Hosenball's statement goes on to explain that:

"This permits orderly attempts to establish that such exploitation is in fact feasible and practicable, by making possible *experimental beginnings, and, then, pilot operations,* a process by which we believe we can learn if it will be practicable and feasible to exploit the mineral resources of such celestial bodies. (emphasis added)"

The United States' effort to preserve its legal rights to engage in resource development under the treaty clearly stops short of full-scale exploitation. Moreover, there is a strong legal inference, arising under paragraph 2 of Article VI and paragraph 8 of Article XI, that *commercially-oriented* enterprises are even barred from engaging in the kind of experimental or pilot operations described in Mr. Hosenball's statement above. The treaty permits the use of resources in "scientific investigations." Thus the issue is the definition of "scientific investigations." To the extent that it excludes research and development activities undertaken by a commercial entity in the hope of future profit, paragraph 2 of Article VI would prohibit such an entity's using resource samples collected from the Moon and other celestial bodies—either for research and development or for the support of its missions. Paragraph 8 of Article XI reinforces this apparent prohibition on the conduct of interim resource activities by states and persons who are not pursuing scientific purposes.

. . . commercial application of outer space technology will be subject to the greatest insecurity imaginable.

It is highly doubtful that the Department of State would support authorization of U.S. nationals to engage in the commercial exploitation of Moon resources prior to agreement on a new international regime, even if it is possible to make the legal case that the treaty does not prohibit these activities. State authorization is required under paragraph 1 of Article XIV (as it is under Article VI of the 1967 Treaty of Principals). An affirmative act by the United States to permit commercial development of the Moon's resources by private entitites would probably require legislation and would be deemed by the State Department as interfering with the international negotiations.

Finally, the practical effect of an international commitment to negotiate a new, unknown legal regime covering Moon and other celestial resources will be to deter industrialists, and probably governments, from spending research and development dollars in related activities during the interim period. The precedent of the U.N. Conference on the Law of the Sea will convince them that Third World demands at the "Moon Conference" are going to be extreme, that existing investments may not be respected under the resulting treaty, and that the industrialized countries may not be very successful in negotiating a system of exploitation that permits commercial or industrial use of the resources under realistic terms and conditions.

Article XI of the Moon Treaty embodies the basic principles to be implemented in the future resource regime. Paragraph 1 established that the Moon and its resources are "the common heritage of mankind," a concept to be interpreted both in the context of the Moon Treaty and the future resource agreement. Yet the common heritage concept has already been the subject of protracted debate in the international community in relation to deep seabed resources and thus is deemed by many nations to have an independent meaning.

For developing countries, "common heritage" means common ownership of the resources and majoritarian control over their disposition. This translates into insistence that no single country, or entity under its control, has the independent right to use the commonly owned resource. Access to the resources must first be approved by the international community on the basis of one-nation, one-vote. As a result, the developing countries would collectively control who is allowed to exploit and use the resource. The concept of the "common heritage of mankind" does not, in the view of the Third World, recognize that industrialized countries with space technology should have a greater voice in regulating outer space resource development.

. . . the Moon Treaty must be clarified to protect our interests or it must be opposed.

Paragraph 7 of Article XI further compounds the future negotiating difficulties of the highly industrialized countries with space technology. First, it establishes the principles of "orderly and safe development" and "rational management" of the Moon and other celestial resources. Most nations of the world interpret these principles as mandating central planning of resource development and international controls over resource uses and/or marketing. In short, these principles are the antithesis of a free market approach to the exploitation and use of resources on the Moon and other celestial bodies. Today, many believe that free market economics in the traditional sense will have only a small role to play in space industrialization. Yet it may be short-sighted to concede in a binding treaty that the political will of the majority of nations, rather than market-oriented forces, should dictate the pace and substance of outer space resource development.

Second, the principle of "expansion of opportunities in the use of those resources" will ultimately evolve into a Third World position that access to the Moon and other celestial resources must be limited for industrialized countries, so that developing countries have a chance to participate. (The Soviet bloc can also use the principle to insist that Western and Soviet activities using the Moon's resources be kept at the same level of intensity.) The clearest evolution of this concept is found in the draft law of the sea treaty which creates an international mining monopoly for half of the deep seabed's mineral resources, based on the argument that developing countries can only expand their opportunities to use the resource on a collective and subsidized basis.

Finally, the principle of "equitable sharing of benefits" could be interpreted to require a system of international taxation of any profits made by commercial resource developers. Since the term "benefits" is not restricted to the financial realm, the principle also dictates mandatory transfer to all countries of the technology used to exploit the resources.

In conclusion, these are not benign or meaningless phrases upon which to found a new international law governing the use of the Moon's resources. Experience in other forums allows us to predict with confidence the implications for resource activities on the Moon and other celestial bodies:

. . . the Moon Treaty is a dangerous and unrealistic abandonment of basic legal rights that free enterprise will need to work effectively in space.

1. No entity would be permitted to use the Moon's resources in a commercial operation without obtaining authorization from an international organization whose policies and decisions would be made by a U.N. General Assembly-type body.
2. To obtain that authorization, the entity would have to agree to submit a large share of any profits it makes to the international organization and to transfer to other countries on a subsidized basis any technology it uses.
3. Authorization would probably be withheld, if the entity was from a country that was already exploiting Moon resources.
4. Ultimately, no national entity would be permitted to exploit the Moon's resources; instead an international monopoly would be created.

Most of the technological alternatives being considered for the commercial use of outer space ultimately require use of the Moon, and probably use of its resources in one capacity or another. It is particularly important that the Moon Treaty does not attempt to define the term "natural resources." Therefore, it seems reasonable to conclude that, if there is ever to be *any* industrialization of outer space, it will involve commercial exploitation of some natural resource of the Moon or other celestial bodies.

Congressional Testimony on the Moon Treaty

On September 6, 1979 the Subcommittee on Space Science and Applications of the Committee on Science and Technology of the U.S. House of Representatives held hearings during which Congressman Breaux, NASA General Counsel Neil Hosenball, and Leigh Ratiner presented their views on the Lunar Treaty. Ratiner's opinions have been substantially set forth above.

Hosenball reviewed the background of COPUOS at the United Nations and recited a history of the negotiations that resulted in the present Moon Treaty. He discussed the comments that he and previous U.S. representatives placed on the record to represent the official U.S. interpretation of the Treaty.

Congressman Breaux, who was a U.S. congressional advisor to the law of the sea conference, analogized the law of space to the law of the sea. He pointed out that the Moon Treaty is only one of a broad array of evolving "north-south" accords between developed and undeveloped nations. Breaux described and listed numerous close parallels between the Moon Treaty and the 1970 U.N. Resolution on the deep seabeds.

Breaux especially pointed out that unilateral U.S. statements intended to interpret treaty language had not been effective in the past to protect U.S. interest.

"I'm deeply concerned that the Moon Treaty could contribute substantially to the futher erosion of the position of the United States and the other Western industrialized countries. I'm reassured neither by the fact that the development regime for celestial bodies will be negotiated later, nor by the argument that, in the meantime, the United States is protected by its unilateral statements on the record, which have apparently been uncontradicted thus far. I would like to point out that, in the Law of the Sea context, the United States in the mid to late 1960s felt comfortable with a similar situation, that subsequently found that what it perceived to be protections were not protections at all. I would also like to observe that the Moon Treaty contains ambiguities of the same sort that lead to serious difficulties to the United States with respect to the deep seabed.

If the Third World and the Soviet bloc could contend that universally applicable customary law, establishing a binding moratorium (on commercial development of deepsea resources), could spring from a General Assembly resolution, how much more easily could they argue that the same consequences derived from a treaty? Such a position taken by the Third World and Soviet bloc with respect to development of outer space resources could have a seriously adverse effect on a negotiating position on the future exploitation treaty. Investment uncertainties would result and, as this happened with respect to ocean mineral development, the exploitation of outer space resources would be seriously retarded."

Breaux concluded that acceptance of the Moon Treaty is not in the best interests of the United States:

"I believe, Mr. Chairman, that the long-term economic implications for the United States would be extremely adverse, if the United States were to repeat in the outer space context the mistakes committed with regard to the deep seabed . . . I believe that for the United States to accept a kind of situation presaged by the draft Moon Treaty is to invite a serious erosion of our material, legal and equitable position in the international community. Like the Law of the Sea Treaty and the Code of Conduct on the Transfer of Technology, the Moon Treaty must be clarified to protect our interests or it must be opposed."

Conclusions

International law allows sovereign states complete freedom to engage in any activity that is not expressly prohibited by law. Today the U.S. has a perfect right to exploit space resources for profit. The Moon Treaty does not give the U.S. new rights, it only limits existing U.S. rights to use space resources for scientific purposes and takes away the U.S.'s existing right to exploit such resources for profit. It must be stressed that the Moon Treaty does not create even a single new right beyond those the U.S. already enjoys under existing international law. Far from being a fair balance between the needs of free enterprise and the less developed countries, the Moon Treaty is a dangerous and unrealistic abandonment of basic legal rights that free enterprise will need to work effectively in space. The Moon treaty introduces substantial uncertainty and risk for private sector investment in space ventures that would exploit space resources for profit.

. . . the U.S.S.R. and its supporters in COPUOS . . . are executing a careful and deliberate program intended to limit the entry of free enterprise into space.

Space industrialization requires the establishment of realistic laws. To determine what law will be appropriate in space, it is necessary to examine why humanity is expanding into this new environment. Three principal forces, the

academic, military and commercial, interact to impel humanity into space. With the exception of communications, U.S. involvement in space is entirely academic or military. Present space law, including the Moon Treaty, has been forged almost entirely out of high academic ideals in *advance* of any practical commercial reality. **True space law, if it allows free enterprise to operate at all, will evolve to** meet the needs of practical commercial **ventures. In this author's opinion, practical business space law would, if not preempted, evolve shortly after space-based exploitation of basic resources and energy begins to yield substantial profits. History teaches that the transition between academic and practical legal regimes can be gradual or traumatic, but that such transitions inevitably occur.**

Ominously, the world now spends more for military purposes in space than for academic studies. The only remaining substantial possibility for free enterprise non-military development of space requires large scale commercial development of basic natural resources, i.e. raw materials and energy from space. Only basic raw materials and energy from space can return a profit commensurate with the capital expense and risk that will be required to start up space industry. Only large scale development of these basic space resources can provide sufficient economies of scale to permit development of space as an industrial frontier by free enterprise capitalism.

Such large capital investments cannot be made without clear legal guidelines that allow commercial operations to exploit space resources for profit. Free enterprise institutions simply cannot make significant investments in space while they are under the threat of suit over treaty terms or ex post facto appropriation of their investments by a nebulous future international regime.

Finally, it is clear beyond reasonable doubt that the U.S.S.R. and its supporters in COPUOS have and are executing a careful and deliberate program intended to limit the entry of free enterprise into space. Since the U.S.S.R.'s introduction of the draft Treaty of Principles in 1962, the Soviet Union and its allies have fought constant delaying actions to chill free enterprise investment in space as a new industrial environment. It is an unfortunate commentary on the will and vision of the United States and other Free World nations that the U.S.S.R.'s program has been so successful.

An annotated, updated version of this article will be published in the Winter 1979 **Houston Journal of International Law**.

L-5 Board of Directors member, Hon. Edward R. Finch Jr., speaks out in favor of the Moon Treaty:

As the L-5 NGO (non-governmental organization) delegate to the United Nations, I write to advise concerning the new Moon Treaty currently before the UN General Assembly. I have followed the draft treaty on the Moon and other celestial bodies (UN Doc. A/34/20) for the past seven years it has been under discussion in the UN Committee on Peaceful Uses of Outer Space (COPUOS). Careful review of the proposed Moon Treaty indicates the following:

1. As pointed out by US Delegate Hosenball in UN Doc. A/AC.105/PV.203, dated July 16, 1979:

"The draft treaty, as part of the compromise by many delegates, places no moratorium upon exploitation of the natural resources on celestial bodies pending establishment of an international regime. This permits orderly attempts to establish whether such exploitation is in fact feasible and practical by permitting experimental beginnings and then pilot operations, a process by which we will learn if it will ever be feasible to commercially exploit the mineral resources of celestial bodies. My Government will, when and if negotiations for such a regime are called for under Articles XI and XVIII, make every effort to see that such a regime is successfully negotiated."

Further, this in no way detracts from scientific research utilizing celestial bodies' resources by anyone.

2. It must be remembered that the general principles of the 1967 Outer Space Treaty, e.g., the freedom to explore and use outer space, including the Moon and other celestial bodies, remain applicable. The US has made this clear before COPUOS, UN Doc. A/AC.105/PV.203:

"In regard to the matter of the Moon Treaty's relation to the 1967 Outer Space Treaty, discussion in this Committee resulted in no statements to the effect that the Moon Treaty is intended to weaken in any way the provisions of the 1967 Treaty. In this light, and taking into account the last two paragraphs of the Moon Treaty, there was a feeling that a nonderogation provision in the Moon Treaty would be superfluous .... Our delegation accepted this view and joined in the consensus on the Moon Treaty with the understanding that it in no way derogates from or limits the provisions of the 1967 Outer Space Treaty."

3. The proposed treaty in Article VII contains important protection of the environment. To quote Mr. Hosenball again:

"The Committee agreed that Article VII is not intended to result in prohibiting the exploitation of natural resources which may be found on celestial bodies other than Earth, but rather that such exploitation will be carried out in such a manner as to minimize any disruption of or adverse effects to the existing balance of the environment."

The L-5 Society should encourage informed debate on the interpretations of the proposed treaty. To be avoided are hasty interpretations, inappropriate analogies and unwise political action tending to diminish L-5's role in advancing activities in outer space.

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4. Organizational models for the exploitation of space resources continue to be designed. The proposed treaty does not favor or prohibit any single set-up. An INTELSAT-type enterprise, for example, would be completely permissible under the terms and would provide the opportunity for an "equitable sharing of benefits." A system of international taxation of any profits is not required. Nor is a mandatory transfer of technology dictated by the terms of the proposed treaty.

Participation by US industry could be through a COMSAT-type organization. As is well known, COMSAT acts as manager for the INTELSAT global communications system. The opportunities and prospects for private enterprise, working through such organizations, are enhanced by mutual cooperation under the proposed treaty, not diminished. In addition, such arrangements would certainly include provisions for the recovery of costs.

5. No presumption should be made that an entity, such as the proposed International Seabed Authority, is desirable for the Moon. Quite the contrary, the model

for success in space enterprises is INTELSAT which by its business-like approach offers to all nations the benefits of (i) opportunities for participation and (ii) decreasing costs in domestic and international communications.

6. Further consultations as provided in the treaty are not anticipated for at least eight years as scientific research and pilot projects would have to continue for a considerable period before the possibility of commercialization arose. Commercialization should be discussed more appropriately when feasibility has been proven and solar power systems, space manufac**turing facilities, and even small space habitats are more practical realities.**

7. With regard to the "common heritage of all mankind" language is used in the treaty, three points need to be made. First, it is to be noted that the phrase is not "common province" as stated in the 1967 Outer Space Treaty. There is considerable consensus that the distinction is declaratory only and the subject is discussed at length in a recent article on semantics and decision-making in the **Journal of Space Law**, Spring 1979.

Second, no consensus has been reached on the meaning of "common heritage" and "common province" in the international law of outer space. And finally, recourse to law of the sea rhetoric should await conclusion of that treaty and successful development of seabed resources. Lessons on what to avoid are more likely from law of the sea experiences, rather than actions to be duplicated for the Moon and other celestial bodies.

Conclusion

The Committee on the Peaceful Uses of Outer Space has already produced by consensus five treaties which have been ratified by the US and which have made exemplary progress in the law of outer space. This treaty seems most appropriate, considering the rapidly advancing science for the use and development of resources from space for the benefit of all mankind.

The L-5 Society should encourage informed debate on the interpretations of the proposed treaty. To be avoided are hasty interpretations, inappropriate analogies and unwise political action tending to diminish L-5's role in advancing activities in outer space.

In particular, it is my feeling that there should not be "quick . . . political action in Washington" with regard to defeating this treaty before the US Senate as suggested by Leigh S. Ratiner in his letter of August 15, 1979.

The Soviet Union, by its Delegate Kolossov, indicated before COPUOS that his delegation would "make no hasty interpretation of the meaning behind each article of the draft agreements, its possible impact on further developments in international cooperation in outer space, or its potential impact on the further development of international space law." UN Doc. A/AC.105/PV.203. The writer supports this view as do many other outer space lawyers. Hasty analogies to the law of the sea can result in misleading presumptions and conclusions. Lawyers who have worked in *outer space* international law understand the dangers in attempting the application of analogies from elsewhere to the unique space environment.

The Senate may vote on the proposed Treaty as early as January. You can write to your Senator to express your views at the following address:

U.S. Senate
Washington, D.C. 20510

L-5 Speaks to DOE: There's an SPS in Our Future

by Annita Harlan

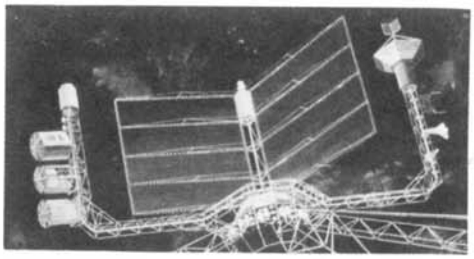
Your voice is being heard.

In October the Department of Energy received a report of last May's Solar Power Satellite questionnaire sent to L-5 members. The questionnaire asked members what they thought of the SPS concept, their opinion of the U.S. government's conduct of the SPS program, about the adequacy of designs and of impact studies already accomplished or underway, and for personal information intended to illuminate the nature of the SPS-interested public.

In all, 850 replies were received from the membership. This was considered a gratifyingly large response by PRC Systems Sciences Co. which is coordinating the public interaction program for DOE.

Carolyn Henson and Annita Harlan analyzed a random 10% of the responses, the whole of replies from women (only 72), and the detailed comments of especially knowledgeable members who had examined the background documents prepared by DOE.

The input of the participating public groups: L-5 Society, Forum for the Advancement of Students in Science and Technology, and Citizen's Energy Project, has been focussed into about 40 questions from the concerned public for DOE consideration. These will be sent by PRC to target experts within DOE for their detailed response. These questions, which showed the depth of information and interests of the memberships, will be reported in future **L-5 News** issues.



The message of L-5 to DOE:

— Solar power satellites look like a prime option for future energy needs.

— Private enterprise will be interested in SPS.

— The U.S. government should have a supportive and regulatory hand in the project.

— International involvement means complications for sure, but possible rewards for Earth as a whole.

— The new Moon Treaty could **severely inhibit use of extraterrestrial materials.**

— The Reference Design needs major revisions.

— There's going to be Big Trouble if environmental and social impacts are not calculated into the cost/benefit analysis for SPS development and deployment.

— If SPS is going to increase centralization of power, it better provide big rewards — like clean, cheap power.

— Earth resources should not be depleted.

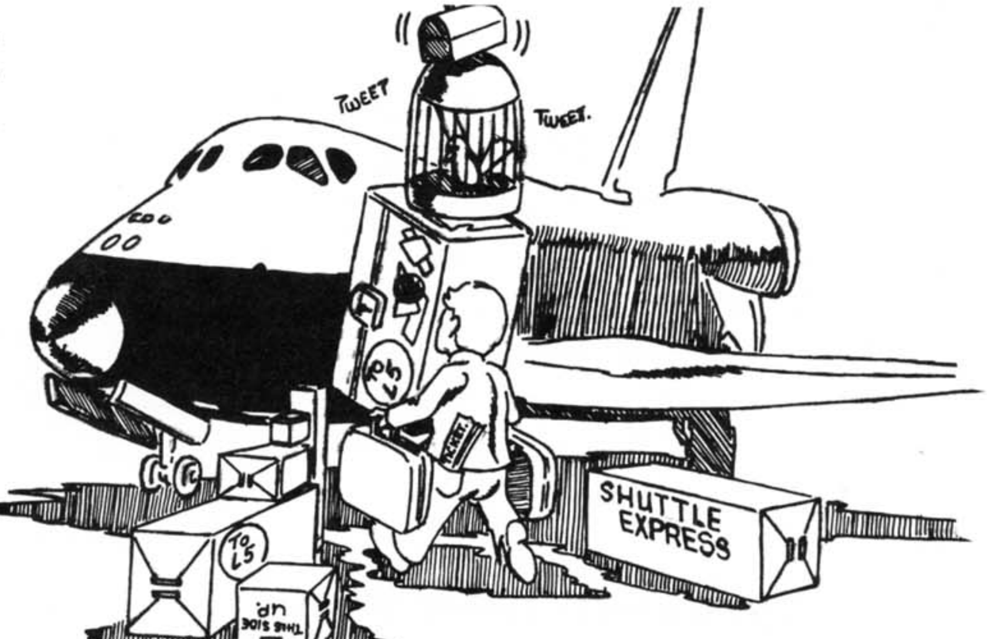
— SPSs have military implications; that's good, and that's bad.

— SPS is a steppingstone to the stars.

Shuttle Express

How much will it cost to use the shuttle?

by Ed Bas



Artwork by James Babcock.

My first plane trip (and it wasn't terribly long ago—I led a sheltered life) came by way of a marvelous creation called the "student standby." I got from Michigan to California for less than $200, round trip, with the added adventure of not knowing for sure when I'd arrive. That made it all the more exciting. At least it did when I was 17 years old.

You can't fly standby anymore, but you can send a package that way aboard the Space Shuttle. You stand to save a bundle on the first shuttle flight if you're not particular about when you fly and have a small self-contained payload. The bargain basement rate: $50 per pound. Other U.S. agencies and participating foreign governments would pay $247, and "all others" would pay $292.

If you're in that latter category and in a hurry, you could pay up to $389 per pound.

The U.S. Department of Defense is guaranteed a lower rate ($187 per pound) not in the national interest but because D.O.D. has its own space launch system—in other words, competition is keener.

Why the differences? It's the old law of supply and demand. If you're in a hurry, you have to be willing to pay. If your package is larger or heavier than the minimum, you'll have to pay for that, too.

But William A. Jordan, of New York University, writing in the **Journal of Contemporary Business,** points out some possible flaws in the shuttle's pricing policy.

NASA, Jordan states, is in business to encourage fullest use of the shuttle, yet "as a matter of national policy, Space Transportation System (STS) operations must charge fees which cover the costs." Those two policies can be inconsistent and even contradictory, according to Jordan. One flaw is the lack of regulation by demand. If NASA reaps a windfall business, who pockets the profits—the public, or industry through lower future rates?

And if it takes in enough, does NASA get hit with even further budget cuts down the road?

NASA also may have made the mistake of holding the prices consistent, at least through 1983. Adopting the fixed price schedule for shuttle flights during the first few years could encourage potential users. Of course, this naturally only applies to price increases—no customer is going to complain if the price is dropped, but it might raise a few eyebrows in the federal Office of Management and Budget.

Jordan suggests that NASA could have refrained from announcing any price schedule at all—"instead, negotiate separately with every potential user for each dedicated or shared-flight payload." This is known as perfect price discrimination, but could easily have political repercussions over who is charged what.

An even more complicated "multipart pricing" could be charged to more accurately reflect future demand. This would reduce the present 5% minimum load factor (the smallest percentage of the total shuttle payload capacity, outside of the "Getaway" that NASA is willing to sell) now required for shared flights. Instead of the huge financial leap between a "Getaway" and the present minimum $1 million charge for a standby payload, a 1% payload for "only $258,000" might be established.

The figure is Jordan's, but clearly shows an outlet for industry and yet incentive enough (a 25% savings) to go to the larger 5% load. Or the 5% could be contracted for initially by a large company and spread over several flights to get around that 5% one-shot figure.

Regulation of the monopolist might come later. The word has a sour connotation to most Americans, and with good reason. A monopolist controls its prices. A customer has nowhere else to turn. But if there's a justification, it's that NASA won't be twisting any arms. It will be the lure of profits that encourage use of the monopoly.

The other point is that NASA will hopefully have a short-lived monopoly Any changes in its present pricing policy could just make money but could also backfire by limiting future markets. Hopefully, competition is not far off—one sure way to break the monopoly. Until then and until we have a number of space-going firms to draw upon (Orion, Ltd., Luna Enterprises?), we have to give NASA the reins to get the most from its position.

NASA Vindicated

by Carolyn Henson

October 16 a Carter-appointed team investigating shuttle delays and cost overruns turned in their verdict: the shuttle program is healthy, faces no currently unsolvable problems, and is run by competent people.

So who's the villain behind shuttle problems? Carter's team fingered chronic underfunding caused by penny-pinching politicians which have kept NASA living hand-to-mouth, unable to tackle the problems they've seen looming on the horizon. The team found that shuttle delays were a consequence of having to stretch out development in order to remain within yearly budget constraints.

Space shuttle delays and cost overruns had inspired Carter to appoint a three-man team to investigate NASA management. The members of the team, retired Vice Admiral Levering Smith (former director of Strategic Systems Projects), William A. Anders (Apollo 8 astronaut and General Manager, Nuclear Energy Products Division, General Electric) and Dr. Robert A. Scarpie (President, Cabot Corp. and former President, Bell and Howell), each worked independently of the others. But they all arrived at essentially the same conclusions.

In testimony before the House Space Science and Applications Subcommittee the morning of October 18, NASA Administrator Robert Frosch reported on the shuttle: 10% chance of flying by next April, 50% chance by July, and 80-90% by September. That afternoon Carter's study team reported, recommending that NASA give more attention to the needs of shuttle users. In response, Frosch has already set up a new Office of Space Transportation Systems. He expects to appoint its head by mid-November.

This recommendation came as a relief to NASA-watchers who had been apprehensive about rumors that shuttle operations might be moved into the hands of the people who brought us Amtrack. Carter's team's recommendation to run shuttle operations within NASA is a vindication for a long-embattled agency which has, since 1971, had 40% of its employees forced out by budget cuts.

On November 5th, Frosch will report the findings of Smith, Anders and Scarpie — that NASA's problem is lack of money — to Jimmy Carter.

Studying Flares From Space

by Joseph Rothenberg

*Reprinted with permission from Grumman Aerospace **Horizons** Magazine, Volume 15, No. 2, 1979.*

A significant boost to the worldwide effort to probe solar energy processes during the present solar maximum will come from the Solar Maximum Mission (SMM) observatory satellite, or "Solar Max." In a program managed by the NASA-Goddard Space Flight Center, Solar Max is scheduled to be launched into Earth orbit on January 31, 1980.

The only space platform devoted to studying the physics of solar flares in the 1979-81 period, Solar Max will be operating cooperatively with other ground and space observatories during the International Solar Maximum Year.

> ***In its 300-mile-high orbit, Solar Max will provide scientists with their primary vantage point. Its integrated package of seven different experiments . . . will operate in selected wavebands, letting us . . . focus in on flares.***

The reason for our fascination with flares is that they represent an enormous, very rapid release of energies measured in ergs, approaching 10 to the 30th power *(or 100 times the total annual electric power demand of the U.S. today).* While SMM observations will aid solar-terrestrial studies, our project scientists will be primarily concerned with exploring such mysteries as: Where in the solar atmosphere do these bursts of energy originate? How is the energy built up or stored? What triggers its release and propagation out through the Sun's atmosphere to the region of the Earth and beyond?

In its 300-mile-high orbit, Solar Max will provide scientists with their primary vantage point. Its integrated package of seven different experiments—the specific strength of Solar Max—will operate in selected wavebands, letting us monitor active regions and focus in on flares.

Several theories attempt to explain the fundamental energy-release process of flares, and Solar Max is "open-minded" to all. Here's what many scientists tend to postulate: First, a buildup of a very intense magnetic field in an active region. Then, in time, more and more energy is built up until the field is *annihilated*—fieldlines break up and reconnect in different, less-energetic forms, creating transitory electric fields of great intensity.

Electrons accelerated by these fields rapidly heat up the normally hot and energetic solar atmosphere over the active region to enormous temperatures (10-20 million deg K). The atmosphere re-emits the energy as radiation in various wavebands in the gamma-ray-to-infrared range. But sometimes so much heat is built-up that radiation alone cannot release it fast enough. That's when the energy induces *mechanical movement* of the solar atmosphere. A shock front forms, plowing a hot, magnetized plasma of charged particles—electrons, protons, and atomic nuclei—ahead of it, accelerating them to nearly the speed of light.

Most significant to flare science are the X- and gamma-rays and light emitted in atomic lines of the electromagnetic spectrum, visible only to instruments such as those carried on Solar Max. It is through these "windows" that we will be looking into the various layers of the solar atmosphere for tell-tale changes that may at last reveal the mysteries of the solar flare.

Grumman's role in SMM is to plan and conduct the flight and ground operations required for the satellite to achieve its objectives. Our contract with NASA runs for one year after launch—the planned life of Solar Max.

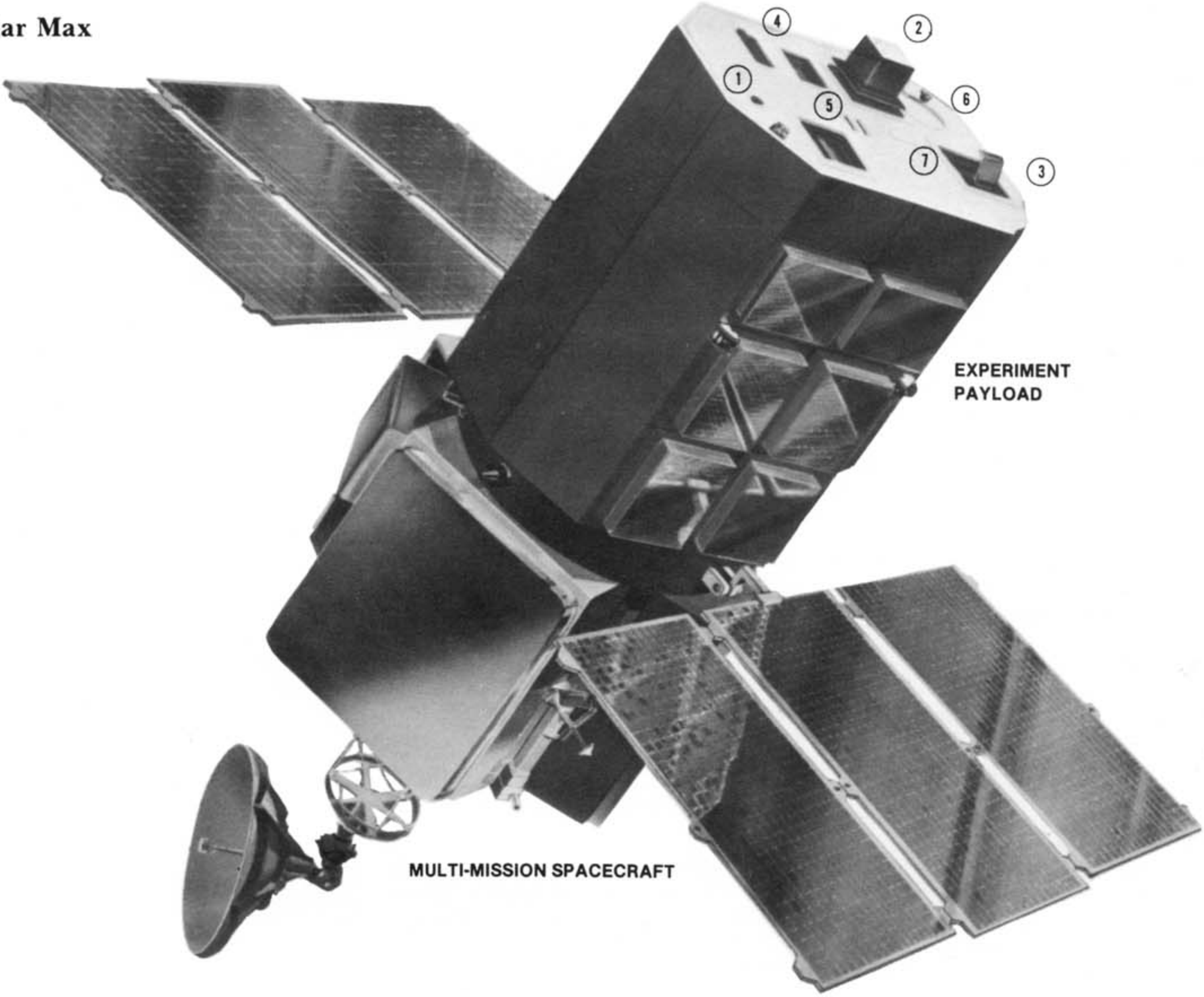
Once Solar Max has been launched, all mission operations will be conducted from two buildings at Goddard: the Operations Control Center (OCC) and the Experiment Operations Facility (EOF). The OCC will house most of Grumman's 22-member team which will manage all the observatory's operations in orbit. It will be up to the Grumman controller to decide when and how to uplink new mission sequences to the satellite and when to command its tape recorders to "dump" their data back to Earth.

Using SMM data and inputs from ground observatories worldwide, the seven principal investigators will jointly take part each day in 10 to 12 Solar Max orbits (90 min. each) of coordinated science. At their own computers in the EOF, they will receive both ground-based and satellite data in near-real time—the fastest response ever provided for this type of scientific mission. They will use the data to predict events on the Sun over the next 24 hours, adjusting the experiment program accordingly.

Grumman engineers in the EOF will help the experimenters plan the joint science program for each following day. We will control optimum pointing of the experiment payload, develop command sequences, and monitor the condition of the instruments during each contact with the satellite. Solar Max has a minicomputer brain of its own, but it needs a little prompting to know how to cope with the transitory explosive events that characterize the active Sun.

Some key Solar Max Mission firsts: first flight of the NASA-Goddard Multimission Spacecraft (MMS); first satellite to use NASA's Tracking Data Relay Satellite (TDRS) to be launched in 1980; and first spacecraft designed to be retrieved and returned to Earth by the Space Shuttle for refurbishment.

Solar Max



1. **Active Cavity Radiometer**—(R.C. Willson, Jet Propulsion Lab) Purpose: To measure Solar Constant with an accuracy of one-tenth of 1 percent. Spectral range: UV-IR.
2. **Coronograph/Polarimeter**—(R. MacQueen, High Altitude Observatory) Purpose: To study transient ejecta from Sun; relate coronal magnetic field and plasma density. Spectral range: 4435-6583A.
3. **UV Spectrometer/Polarimeter**—(E. Tandberg-Hanssen, MSFC/GSFC) Purpose: To study deposition of energy in lower temperature domain. Very-high resolution device monitors Sun's magnetic fields to detect any rapid changes in field where flare went off. Spectral range: 1100-3000A.
4. **X-Ray Polychromator**—(L.W. Acton, Lockheed Palo Alto Res. Lab; J.L. Culhane, Mullard Space Science Lab; and A.H. Gabriel, Appleton Lab) Purpose: To study energy-release processes in flare plasmas over 1.5 to 50 million deg C. Looks at many X-ray spectral lines and produces images representing how much energy is deposited in a specific line and what its temperature and density are. Spectral range: 1.4-22.4A.
5. **Hard X-Ray Imaging Spectrometer**—(C. de Jager, Utrecht) Purpose: To obtain high-resolution imagery of flare processes—determine where energy is deposited, at what height, and over what area—during flare's life. Also serves as an onboard flare finder. Spectral range: 3.5-30 KeV.
6. **Hard X-Ray Burst Spectrometer**—(K. Frost, Goddard Space Flight Center) Purpose: To provide first alert of a flare. Measures how much hard X-ray energy has burst out of Sun's magnetic field, which determines subsequent changes in flare plasma. Spectral range: 30-300 KeV.
7. **Gamma-Ray Spectrometer**—(E.C. Chupp, Univ. of New Hampshire) Purpose: To study gamma-ray-emitting accelerated particles in flare; determine presence and distribution of nuclides as an additional indicator of intensity of flare's energy. Spectral range: 0.3-17 MeV.

The L-What Society?

We recently received the following letter:

With reluctance I am renewing my L-5 membership. I have found the **L-5 News** uninspiring and as I stated in an unanswered letter to the editor most of the information printed can be found in **Popular Science**. Aside from the fever induced by the idea of space colonization nothing much else is emanating from the society's official organ. Nothing dynamic. No action. No fire. "Meanwhile Soviet cosmonaut trainees were growing cabbages as big as ..."

But who knows? This may be the year that L-5 advertises its existence. I can see it now! (fanfare with increase in tempo) Membership forms appear with ads in major magazines. Well known L-5 members appear on the Tonight Show. Bumper Stickers appear "Aerospace Needs L-5" "L-5 Means Jobs" etc. etc. etc. People stop asking "The L-What Society?" As membership forms come flooding in a new political force emerges in America. A force capable of influencing what is done with the space program. People coming to L-5 speaking engagements send money flooding into the society's coffers swelling those funds donated by big business! (crescendo) the L-5 Society becomes a power!

Will it happen? Huh? Will it? Huh? Huh? (Voce Belushian)

Noooooooo! The talents of famous members will go unused. The Society will remain obscure and people will continue to ask "The What Society?". Worst of all the **L-5 News** will continue to print "NASA Report on How to Cook Sausages in Space" instead of "How L-5 Pressured Congress Into Appropriating Funds for Earthport facilities in the Mohave."

M.A. Leptuch
Lakeview Terrace, CA

Perhaps the following report on recent L-5 activities will give M.A. Leptuch new hope:

L-5 Sparks Moon Treaty Opposition

by Carolyn Henson

Only 3 weeks before the now-controversial 1979 draft Moon treaty was scheduled for a Congressional oversight hearing on Sept. 6, the L-5 Society's Legislative Information Service swung into action.

We had learned that Rep. Don Fuqua's Science and Technology Committee planned to hear pro-treaty testimony only. Committee staffers seemed apathetic about **portions of the treaty we saw as serious roadblocks to space development. So** veteran Washington lobbyist and law of the sea expert Leigh Ratiner, whom the L-5 Society has retained for political advice, urged us to turn on the talents of Legislative Information Service participants. Within a few days of mailing an appeal to them we had enlisted a small army of grassroots lobbyists.

Bob Stern, a Gainesville lawyer, was one of the heroes of the "wake up Science and Technology Committee" campaign. He is strategically located in Committee Chairman Don Fuqua's district and is an active worker in Fuqua's Democratic Party. At Ratiner's advice Stern put together an alliance of other party stalwarts and began educating Fuqua and staff about the Moon treaty.

Dr. Larry Wolken, a researcher at Texas A&M University, is another example of an effective worker. While not located in the district of any Committee member, he was able to convince his Rep. Graham to urge Fuqua to allow the L-5 Society to testify on the treaty.

Robin Snelson, editor of **Future Life**, **and Kathy Keeton, publisher of OMNI**, both used their clout as media representatives to impress Fuqua's committee with the need to hear the L-5 testimony.

Leigh Ratiner played a major role with his legal research into the treaty and by advising L-5 people on how best to influence Congress. He also enlisted the support of an old ally from the law of the sea battle, Rep. John Breaux, Chairman of the Subcommittee on Fisheries, Wildlife Conservation and the Environment.

We made a team the Science and Technology Committee couldn't ignore. The Sept. 6 oversight hearing kicked off with Chief Negotiator Neil Hosenball's testimony. While he, as expected, supported the treaty, it was a case of "damning with faint praise." Then the L-5 opposition moved in. Leigh Ratiner took the witness stand, backed up by space researcher and former L-5 President H. Keith Henson, who was there to field technical questions. Ratiner was followed by Rep. John Breaux, who warned that "for the United States to accept the kind of situation presaged by the draft Moon treaty is to invite a serious erosion of our material, legal and equitable position in the international community."

The Sept. 6 hearing is having its repercussions. Shortly thereafter Committee Chairman Don Fuqua and ranking minority member Larry Winn sent a letter to the State Department demanding to know how the Moon treaty could be in the interests of the United States. Dozens of **Senate staffers are now studying Ratiner's and Breaux's testimony and preparing for** the real battle when Carter asks the Senators to ratify the treaty.

The September 6 hearing was a breakthrough for the L-5 Society. For the first time we fielded official representatives at a Congressional hearing. But this was just our first step. The Moon treaty must be either defeated or amended. If we fail, space will become the home of Big Brother. But if we succeed, we will demonstrate that those of us who plan to live and work in space are a people whose strength cannot be ignored.

What are the next steps?

U.S. citizens can alert their senators on the Moon treaty. Write to them c/o U.S. Senate, Washington DC 20510. Your senator can be especially helpful by **complaining about the treaty to Foreign Relations Chairman Frank Church. And if** the treaty goes to the floor of the Senate for **ratification we will need 34 senators on our side in order to block it.**

We would appreciate it if you would **send copies of your letters and the senators' replies to both the L-5 Society and Leigh** Ratiner, c/o Dickstein, Shapiro and Morin, Tenth Floor, 2101 L. St., Washington DC 20037. We need this information so **we can keep track of the senators' positions on the treaty.**

The L-5 Board of Directors has set up a study group to develop an alternate Moon treaty which will guarantee the rights and liberties of space settlers, protect and encourage developing nations in the use of space, and ensure the rapid development of the resources of space.

It falls to the L-5 Society, as the organization of the top researchers and space law experts of the world, to take the lead in the development of space. But in order to do that we need your help. If you wish to get further involved, write in to the L-5 office, 1620 N. Park, Tucson, AZ 85719 and ask to be added to the Legislative Information Service.

Do our children receive an Earthbound education? Teach them that space is in their future.

Space Colonization In The Classroom

by *Lawrence C. Wolken*

Artwork by Robert Cannon

Since the early part of this decade, public interest in space has seemed to decline. The major problem facing space enthusiasts is, "How can the general public be made aware of the potential benefits of space?"

Few people have turned their attention to the public schools as a solution to this problem. An ideal place for the study of the potential benefits of space is the American history classroom. This is a course that must be taken by every student in the country. This provides the broadest possible exposure for information about space. It utilizes an information distribution system which already exists, eliminating the problems of developing and implementing a new system. Since it is unlikely that American history will ever be dropped from the school curriculum, this approach, once begun, could continue indefinitely. Since the course lasts at least one semester (approximately 15 weeks), it allows for a relatively long period of exposure to space information. But the success of this program depends on showing history teachers how this approach will benefit them. Their enthusiastic support is essential.

History is one of the most difficult subjects to hold the student's interest. Supposedly, we study history so we will not repeat the mistakes of the past. However, it is often difficult to see how the problems of several hundreds of years ago relate to those we face today. Space can help bridge this gap between the past, present, and the future while at the same time keep students interested in their history class.

Some of the parallels between the past and the present should come to mind quickly. Columbus and other explorers were financed by governments. The same is true for the U.S. and Soviet space programs. The New World produced many resources and untold riches for the Old World. Will space, through solar power satellites, provide the world with the energy it so desperately needs? What other presently unknown riches does space have to offer us? The early colonies in America were financed through private investments by companies seeking to make a profit. Will the first space colonies be financed by private or public funds? This is a question being hotly debated in Congress today. These are just a few of the more obvious similarities between the past and the present. Many other parallels exist but are less well known.

An ideal place for the study of the potential benefits of space is the American history classroom.

Prince Henry of Portugal built a shipyard to develop new types of sailing ships which could sail in the open waters of the Atlantic Ocean. He also started a special school for navigators where they experimented with new methods of navigation, maps and instruments. How different is this from the NASA centers, the training of astronauts, and the development of the aerospace industry?

Beginning in the latter part of the fifteenth century, many European nations were interested in finding a new route to the riches of Asia. The ensuing period of exploration and discovery was dominated by two countries, Spain and Portugal. Spain concentrated its efforts in a westerly direction while Portugal sent its explorers around Africa. Also emerging during this time period were national rivalries as strong monarchs competed for national power and prestige.

A similar situation is occurring in the twentieth century. In this early stage of the exploration of space, the United States and Soviet Union are the dominant countries. The Cold War between the two world powers played an important role in the race to the Moon during the 60's. Will America and Russia lose their world leadership positions just as Spain and Portugal did? Will Germany, Japan, and China, through efforts in space exploration and colonization, emerge as the dominant nations of the future?

During the American colonial period, England practiced a system called mercantilism. Colonies were viewed as a means of increasing England's power by increasing its wealth. The mother country developed manufacturing and established monopolies in foreign trade so it could accumulate gold and silver through a favorable balance of trade. The colonies were viewed as a readily available supply of natural resources and a market for manufactured goods. The resulting restrictions placed on the colonies eventually led to the American Revolution. When the United States establishes its first space colonies, will we repeat England's colonial policies? Will the United States be the "mother country" of the next American Revolution?

Today's generation of students may become the first inhabitants of space colonies. What type of government will be set up in the colonies? Will a constitution similar to that of the U.S. be adopted? Can future space colonists benefit from America's two hundred years of experience and draft a better constitution? Many of today's students may very well face this question during their lifetime.

Using space in American history classes has been the topic of several teacher workshops conducted in Texas this year. The participants have been very enthusiastic about the idea. Teachers need to be exposed to this approach and to the wide variety of materials available for classroom use. For further information about incorporating the exploration and colonization of space into history classes, contact:

Dr. Lawrence C. Wolken
Center for Education and Research
in Free Enterprise
Texas A&M University
College Station, Texas 77843
713-854-7722

For those who sincerely want to develop a greater public understanding of space and its potential benefits, the history classrooms of the nation offer a golden opportunity. This will not yield immediate results but its effects will be widespread and long lasting. Today's students will be tomorrow's voters and will help shape the nation's goals. Perhaps the most important decision they will face is whether humankind will venture into space or remain bound to the Earth's surface.

Book Review

Enterprise, Jerry Grey, William Morrow & Co., 1979
Reviewed by Carolyn Henson

At last—an insider's view of the people and events behind the space shuttle! Author Jerry Grey, Public Affairs Director of the American Institute of Aeronautics and Astronautics, has been either personally involved or close friends with nearly every who's who of the modern space era. He gives us the inside stories on space colonization pioneers Gerard K. O'Neill, Tom Heppenheimer, "Mother Earth" Henson and covers the formation of the L-5 Society. He details the politics and corporate warfare that gave birth to the space shuttle design and points the finger at the Senators and scientists who tried to kill the shuttle.

Political activists will be fascinated by Grey's blow by blow account of the creation of NASA and the ups and downs of the Apollo program. Besides crediting the obvious stars, Presidents Kennedy and Johnson, Jerry Grey's **Enterprise** brings to light previously unsung heroes such as committee staffers Glen Wilson, Jim Gerhig and Charles Lombard.

Those of you who are hardware fans will enjoy the detailed accounts, complete with diagrams and artist's conceptions, of how historically important design decisions were made. Why did Apollo use the lunar rendezvous? Why is the shuttle a delta-wing lifting body? Grey explains so clearly that even nonengineers can appreciate the design process.

Grey writes with a remarkable sense of humor and shows the people behind the space age as warm and genuinely human. You won't be able to put down his book until you've read it all, especially if you wonder if you're in it (hint: check the index).

I must make a confession before signing off on this review. Grey shows the L-5 Society and myself in a remarkably sympathetic light (he's one of the earliest L-5 members, by the way). So I'm clearly biased. But if you can find **Enterprise** at your local bookstore (raise heck with the manager if you can't!) just open it at random and start reading. You'll be hooked.

Enterprise, a hard cover book, can be ordered from the L-5 Society for $10.00 each plus $2.00 shipping and handling. Mail orders to L-5 Society, 1620 N. Park, Tucson, AZ 85719

Reading News

Apollo:
Ten Years Since Tranquility Base

Edited by Richard P. Hallion and Tom D. Crouch. Available from Smithsonian Institution Press, Box 1579, Washington, DC 20013, $6.95 paper, $17.50 cloth.

On the tenth anniversary of that historic voyage for all mankind the Smithsonian Institution's National Air and Space Museum has created this collection of essays about the Apollo program which attempts to put it in a historical perspective from the vantage point of a decade later. Written by experts in the fields of astronautics, history, art and public policy, the sixteen essays outline the mammoth effort required to reach the Moon. Even more important, is the discussion of the ultimate benefits of the mission: the scientific harvest reaped from Apollo 11 and the five subsequent Moon landings; the growth of human knowledge; and the general benefits to humanity.

Space Trek:

The Endless Migration

by Jerome Clayton Glenn and George S. Robinson. Warner Books, $2.50.

By 1992, there should be 10,000 people working and living in outer space — in an environment complete with trees, birds and rivers! We have the means, NASA's Space Shuttle Enterprise, and the ways, detailed here in photographs, drawings, charts and diagrams. All that remains to be settled are the debates (political, economic and philosophical) that continue to rage, before we can embark on the greatest adventure of the 20th century. **Space Trek** examines these provocative questions: Do we chance a real "Star Wars" in our race to outer space? Are there urgent reasons for us to undertake such a vast project? What are the risks to the pioneers? Who will be the first to go? The answers are here in this blueprint for a new era: **Space Trek**.

NEWS BRIEFS

Veteran space sciences foe, Rep. Boland (D-MA), is still trying to kill the Jupiter Orbiter Probe, now renamed Galileo. A combination of shrinkage in the weight the Shuttle is expected to be able to launch and growth in Galileo's expected weight have forced researchers to separate its experiments into two launches. Boland says that makes Galileo a new project, which would require a special approval from all four congressional subcommittees overseeing it- one of which Boland chairs.

NASA is expected to resubmit Galileo for approval shortly. In the interim, a House/Senate conference committee has authorized NASA to continue work on Galileo.

How bad are Shuttle thermal protection tile problems? Seven percent of all tiles failed the recent "pull test" which checked their bonding to the orbiter.

A better tile is under development for the next orbiter, 099.

The first flight of Ariane, the European Space Agency launcher, is scheduled for a date between Dec. 8-18. Ariane has been developed at a cost of $660 million, about 1/10 that of the space shuttle. Ariane, unlike the shuttle, will not carry people but will be capable of delivering 1.26 tons to geosynchronous orbit. This compares with 1.8 for the shuttle. Ariane is expected to offer slightly cheaper launch costs than the shuttle.

Ariane's first commercial payload will be Amsat, a satellite developed by and to be used by radio amateurs. Launch is scheduled for March 1980.

An improved Ariane, scheduled for 1983, will be able to loft 2.3 tons into geosynchronous orbit.

The Space Shuttle is expected to get the extra funding needed to fly by at least fall of 1980. The reason? Carter needs Shuttle capabilities for verification of Soviet military strength under Salt II.

How bad are Shuttle cost overruns? According to NASA, in 1971 FY dollars the project has expended $6.115 billion, 18½% over the original expectations.

Staunch R&D and space program defender, Sen. Adlai Stevenson (D-IL), has announced that he is "available" for the Democratic Presidential nomination. Recent Stevenson initiatives include a bill to make it easier for government contractors to retain patent rights, and a "peace-keeping" spy satellite system which any nation on Earth could use to ensure its security.

Earlier this year Stevenson lead an unsuccessful battle to save the Enterprise from being scrapped.

Debate on the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies opened in the United Nations Political Committee Oct. 29. The treaty is expected to be approved by an overwhelming majority of the U.N. General Assembly. The treaty, however, is facing mounting opposition within the United States.

The Salyut-6 radio telescope became tangled with other parts of the space station and had to be discarded by a spacesuited crew member shortly before the team returned to Earth August 19.

Announcements:

NASA to Select New Astronauts

If you have a bachelors degree in engineering, math, biological or physical science with three years experience in the field or three years of work toward an advanced degree you may be able to qualify as a mission specialist astronaut. Other requirements: you must be at least 5 ft. tall, but not over 6 ft. 4 inches.

If you were one of the over 10,000 people **who applied in 1976 but failed to be one of** the only 35 selected, don't be discouraged. Many current astronauts were originally turned down only to be selected for a later group.

This year's deadline for astronaut applications is Dec. 1, 1979. To apply, write to:

NASA Johnson Space Center
Astronaut Mission Specialist
Candidate Program
Code AHX
Houston, TX 77058

If you miss the deadline, or get turned down, don't despair. NASA plans to recruit a new batch of astronauts every year from now on, so you'll have plenty of opportunities.

Oops!

The October **L-5 News** contained the following errors:

Art Dula's Moon treaty article originally had a "fill-in" blank for the date the Moon treaty would be ratified by the United Nations. It was mistakenly changed to read that the treaty had passed the U.N. However, as of this date (mid October) the treaty has not yet passed but is expected to shortly. Peter Vajk's "Design for Success" article missed the credit line that it was a slightly condensed version of his testimony before the House Science and Technology Committee hearing on the Space Industrialization Act of 1979, held June 27, 1979.

Even the masthead got slightly scrambled. Carolyn Henson was listed under "membership services"! While she wrote, edited, aided in the research of, or solicited much of the material that appeared in the October **L-5 News**, she did *not* work in membership services.

We also received this correction from T.A. Heppenheimer:

"The article 'A Place in Space," on p. 17 of the October issue, was credited to T.A. Heppenheimer as the author. Dr. Heppenheimer states that he did not write this article; that it was pieced together by staff members from material he submitted to the **L-5 News** in 1975, taken together with other material by other writers; and that it reflects neither his current views nor his current understanding of the problems discussed therein."

Stanford Professor Wins Mitchell Prize

Paul R. Ehrlich of Stanford University, leading biologist and well-known author of the best-selling **Population Bomb** was selected as first-place winner in the $100,000 Mitchell Prize program (announced in the December 1978 **L-5 News**). This international awards series is designed to stimulate original thinking on growth-related issues.

Ehrlich, a professor of population studies in Stanford's biological sciences department, will receive $10,000 for his winning paper entitled "Diversity and the Steady State." In it, he discusses genetic, cultural, and technological factors affecting humanity's future.

Space Exhibition

In the tenth anniversary year of mankind's Giant Leap, Wildcliff Museum in New Rochelle, NY, is presenting a participatory exhibition on space travel and colonization, September through December. "Space: The Newest Frontier" is designed to give visitors a feeling for the challenge as well as the excitement of space exploration. It takes you to the frontier of the U.S. Space Program and beyond with a trip aboard a Space Shuttle and a sojourn on a lunar colony.

Beginning with a panoramic overview of aerospace efforts presented in diorama displays, your adventure quickly enters the realm of the future. You experience: a simulated flight to the Moon aboard the Space Shuttle; a lunarium that cradles your tactile and visual senses in the exotic textures of the Moon's surface and in a lunar rover; a lunar colony where you will meet Duna, the Wildcliff robot, who will introduce you to the command center of the colony. There you perform geological and biological experiments. You will exit the colony via space ship filled with aliens who sell gifts and souvenirs.

The exhibition will be open Sunday through Thursday from 1 to 4:30 p.m. Call (914) 636-2108 for further information.

High Frontier Trading Post

The High Frontier Trading Post is an L-5 member service; each noncommercial member is entitled to one free ad per year, not exceeding 40 words in length. Extra or longer ads will be charged at a rate of $ .20 per word (or $4.30 per square inch). Please allow 3-4 months for your ad to appear. All ads are subject to editorial review.

Speaker: I am prepared to speak on several topics including astronaut opportunities, manned space flight, space budget options, the future space effort. In as much as L-5 groups support a common goal I would appear at such a group without fee or honorarium. However, if travel or an overnight stay is involved, I would ask that expenses only be covered. Paul M. Geyer, 230 E. Grand Ave., Rahway, NJ 07065.

For Sale: Space World '63-'79, **AW&ST** 2/65 to 1/77, many issues of **Wings, Airpower, Air Enthusiast, Aircraft in Profile** bound volumes. Send wants w/SASE. Jim Berry, 4529 SW Hamilton Terrace, Portland, OR 97201.

Inside the L-5 Society

Space Futures Searching for Volunteers

The Space Futures Society is taking another turn for the better! In addition to our normal activity such as publicity for the High Frontier movement in the Philadelphia, PA, area, we are opening up two new endeavors for L-5 volunteers living in the Delaware Valley and South Jersey area.

The two new projects are as follows:

The Space Futures Society is gathering volunteers with engineering backgrounds to work on a low cost space station comprised of discarded Space Shuttle tanks. Private industry, some NASA officials, and the Sabre Foundation have expressed interest in a finished proposal, that we are working on under the auspices of Ron Smolin. Those interested in joining a volunteer engineer group to finish this project write to him at International Ideas, 1627 Spruce St. Phila. PA 19103.

The Space Futures Society is also looking for volunteers to work closely with the Sabre Foundation on various volunteer projects. The projects will be as varied as will be the talents of the volunteers themselves. What we need the most are people who will finish a chosen project once they start. (Please send resumes to Richard W. Bowers, Space Futures Society, 3059 Cedar St., Phila. PA 19134.

Space Activists in Iowa

When the governor of Iowa proclaimed July 20th as "Space Day," it was the culmination of many efforts and the start of many more. The proclamation came into being due to a number of letters sent to the governor independently of one another. And at the signing ceremony a contingent of space activists from Iowa City and myself met for the first time. There we decided to organize a local space activist club which will hopefully be chartered by L-5. Anyone in Iowa who wishes to join us please write to me at the following address:

Matt Hickman
708 20th St.
West Des Moines, Iowa 50265

Discounts for L-5ers

The L-5 Society can now offer a 20% discount on car rentals and hotel rooms in several major hotel chains, including Hilton, Hyatt, Marriott, Fairmont, Omni, Radisson, and Town & Country Hotels, Rodeway Inns, Ramada Inns and Howard Johnsons. One phone call will reserve a room and a car, at a 20% discount.

For more details either write the L-5 Society, 1620 N. Park Ave., Tucson, Arizona, 85719, or call the Frequent Travelers Club (FTC) toll free number, 800-327-8388 (in Florida, 305-672-2200) and mention the L-5 Society. Your FTC membership card will be sent immediately. L-5 members only, please.

Huntsville's Display a Hit!

During the recent 10th Anniversary of the Apollo Lunar Landing, a series of exhibits were set up for special showing in the Alabama Space and Rocket Center. This opportunity was used by the Huntsville L-5 Society to explain the concepts of space habitation and solar power satellites.

The accompanying picture shows Dr. Konrad Dannenberg, L-5 Board Member, and member Carl Konkel holding a model of a gallium arsenide solar power satellite used in the display. Pictures of habitats, lunar colonies and SPS construction were set up, along with a stack of L-5 membership forms. Thousands of tourists go through the Center daily and I am glad to say the forms "sold out" in a matter of days.

It was evident that large-scale space activities *are* in the public's mind based **upon comments overheard near the display. The word is getting around!**

Carl R. Konkel
Huntsville, Alabama

Dr. Konrad Dannenberg (left) and Carl Konkel at the Huntsville Space Day exhibit.

L-5 Montreal

L-5 Montreal was formed at the beginning of May 1979. Its purpose is to act as a coordinating center for all chapters that will be formed in the greater Montreal area, including those organized at Montreal's four universities.

L-5 Montreal intends to fulfill the aims of the L-5 Society: promoting space industrialization and colonization by organizing conferences, meetings, etc.

L-5 Montréal
c/o François Coallier
1816 Ducharme
Outremont, Québec
Canada H2V 1H4

L-5 Montréal a été formé au mois de Mai 1979. Cette section de la société agira comme centre de coordination pour tous chapitres que seront formé dans la région métro politaine de Montréal, incluant ceux en voie de formation dan ses quatre universités.

L-5 Montréal entend poursuivre les buts de la société-mère, que est de promouvoir l'industrialisation et la colonisation de l'espace, par des conférences, seminaires, rencontres sociales, etc.

Dear Space Activist,

The 1980 presidential campaign is starting to roll. We have over a year before the election, and now is the time to make the New Space Program a national issue. It needn't be very hard to convince candidates to state their position. A number of preliminary, information-chocked letters followed by planted questioners at candidate talks might do the trick. After all, L-5 has chapters all over the country including key cities: Los Angeles, Houston, San Francisco, Seattle, Phoenix, Philadelphia, Boston, etc. Just imagine a candidate becoming aware that in every one of these cities (and more) there are people pushing for the New Space Program!

The United Nations New Moon Treaty will make the perfect vehicle for us. Criticizing the Carter Administration's foreign policy is all the rage among Presidential hopefuls now, and if we can convince one to make a media splash by condemning the New Moon Treaty, we will have made an important step on the way to L-5!

With the help of national directors Phil Chapman and Eric Drexler, a group of L-5ers in the Boston area have been brainstorming on what action to take to make the New Space Program an issue in the 1980 campaign. Two of our most definite ideas, letters to candidates and planted questions, have already been mentioned. Other possibilities include: press releases, Public Service Announcements, bumper stickers, buttons, short (two page) position papers, talk shows, posters, and working with other interested groups e.g. the AIAA. We are now gearing up for action.

But even if we do *all* of these things here, we will not succeed if they happen only in Boston. We need the help of other L-5ers, particularly the local chapters. It is crucial that candidates receive letters on space issues from *all over* the country. Equally crucial is that planted questions on space issues come up at Candidates Meetings in as many places as possible.

This could be the most exciting and important project L-5ers have ever worked on! We urge you to bring these ideas up at your next local L-5 meeting. Please look over our list of possible activities, add some of your own, and consider which ones your group can do. Write to us (c/o me at 518 Putnam Ave. #9, Cambridge MA 02139) and let us know of your plans. If we all pull together, this election will be a crucial one for the future of the New Space Program!

Reach for the Stars!
Christine Peterson

Help Needed for Ohio L-5

Due to time constraints and changes in my personal life, I have been unable to do any work on the organizing of OHIO L-5 since the beginning of Spring 1979. Nor do I see a lifting of those time constraints for at least another 2 years. Therefore, I am sorry to say, I cannot organize an OHIO L-5 chapter.

I do urge any Ohio L-5 members who have the time, to try and do what I was not able to. If I can help at all please contact me at the address below.

I would like to thank National L-5 for the help they gave me, and to the local chapters, especially Houston L-5, for sending me copies of their newsletters.

Ohio can be a driving force behind the humanization of space, as well we should be. After all, our state produced the first man on the Moon. We have a reputation to uphold!

Steven Stein
570 Fairhill Dr.
Akron, OH 44313

Letters

As a way to quickly promote the development of space, how about orbital fission power stations? Based on a proven technology, there would be no questions as to potential or unforeseen difficulties. With the exception of the actual mining of ore, or the extraction of small amounts of uranium and/or thorium from other ores, the entire processing and use cycle could be placed in orbit, removing all the various dangers of meltdowns, waste reprocessing and storage, etc., from the end users of energy on Earth. Processing facilities and power plants could be built using lunar or asteroidal resources; spent fuel rods could be reprocessed to extract uranium and plutonium; breeder reactors could be built, far from the hazards of terrorism, theft and accidental contamination (and of protestors), to extend the supply of usable fission fuels; the ultimate wastes could be disposed of in many directions (high orbit, solar escape trajectory, Earth-Moon or Sun-Earth Trojan points) or even be used in further power generation.

The total amount of uranium needed would be small at first; transport capability could be expanded as necessary. The well-known regulatory delays on Earth could be largely bypassed in an environment where there is no ecology to damage in any fashion or local residents to harm.

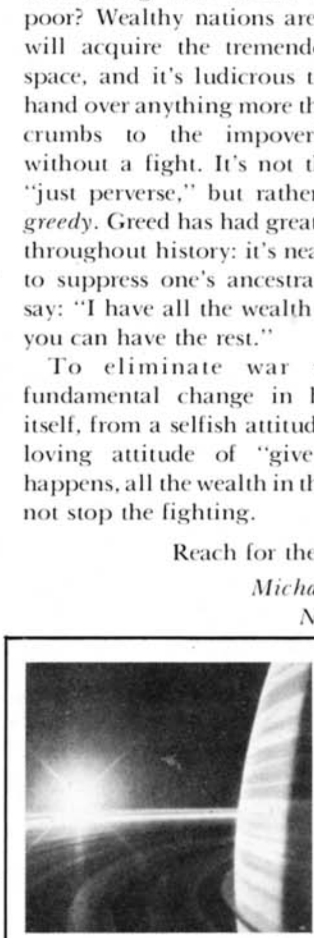
As a long-term solution to the energy problem, of course, this is by no means complete; fission is still a finite source. But it might provide a mid-term solution to public acceptance of both nuclear power and space colonization. And once the manufacturing capability is in place . . .

J.W. Braue, III
Rocky Hill, CT

I sputter in disbelief at the suggestion that material wealth from space will, by itself, end war and civil unrest ("Wealth: The Super Weapon," **L-5 News** July 1979). How does Micky McWilliams propose distributing that wealth to the world's poor? Wealthy nations are the ones that will acquire the tremendous wealth of space, and it's ludicrous to think they'd hand over anything more than a few token crumbs to the impoverished nations without a fight. It's not that people are "just perverse," but rather that they are *greedy*. Greed has had great survival value throughout history: it's nearly impossible to suppress one's ancestral heritage and say: "I have all the wealth I need — here you can have the rest."

To eliminate war will take a fundamental change in human nature itself, from a selfish attitude of "get" to a loving attitude of "give." Until that happens, all the wealth in the universe will not stop the fighting.

Reach for the stars anyway!
Michael A. Pelizzari
Northridge, CA



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1620 N. Park Ave.
Tucson, AZ 85719

L5 NEWS

December 1979

L-5 in Transition
Moon Treaty Update

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

Vol. 4 Number 12 December 1979

In This Issue:

1 **L-5 in Transition: The President's Column.** *President Gerald Driggers looks at the future; ex-President Carolyn Henson looks at the past—with a little help from their friends.*

3 **More on Lightsails.** *Heppenheimer and Frosch agree: pricing is premature.*

4 **Moon Treaty Update: Learning to Make the System Work for Us.** *by Chris Peterson. L-5 lobbyists take Washington by storm. With a letter to Secretary of State Cyrus Vance from Senators Frank Church and Jacob Javits.*

6 **Metalaw and the Moon.** *Gene Roddenberry predicts an end to legal hassles.*

7 **Ratiner Attacks Treaty.** *Washington attorney and L-5 lobbyist appeals to tha AIA.*

8 **Proxmire's Waterloo?** *by Ken McCormick. Harrison Schmitt vs. the pursestrings.*

9 **Message from Mars.** *Something new in Christmas gifts.*

10 **Project Textbook.** *Jerry Pournelle is looking for "a few good" course materials.*

11 **On Your Mark, Get Set . . .** *Stay involved. More SPS opinion needed.*

12 **There Oughta Be a Bylaw.** *Get involved. Answer our questionnaire.*

Trading Post

13 **News Briefs**

14 **XXXth IAF Congress: "Future of Mankind" Has a Russian Flavor.** *Munich hosts cosmonauts. By Frederick Osborn, Jr.*

16 **Book and Article Reviews** *by Conrad Schneiker. Catching up on interesting reading.*

Announcements

17 **Inside L-5**

18 **Letters**

Cover: Experienced air traveler Mr. S. Claus on his first lunar run. Artwork by Robert Cannon.

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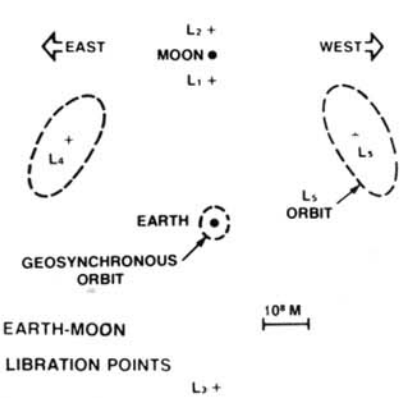

The L-5 Society was formed in September 1975 with the purpose of promoting space development in governmental, industrial and private sectors. L-5 is the abbreviation for the Lagrange libration point number five (see diagram to the left), a proposed site for the final meeting of the L-5 Society before the turn of the century.

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L-5 IN TRANSITION:

The President's Column

This issue of the L-5 News marks an historic occasion; for the first time in the history of the Society, the last name of the President starts with a D and not an H! For **those of you not already aware of it, let me relay that our most beloved former President, Carolyn Henson, is about to bring forth into our world another future space colonist! Physical and emotional strains placed on Carolyn by her many activities and involvements led to the most difficult of decisions: not to seek the office of President again this term. Keith, the other half of this dynamic duo responsible** for the very existence of our Society, felt the responsibilities of the pending birth, his research in space manufacturing and the time-consuming fight against the deplorable Moon Treaty made his assumption of the President's role impossible. It was a great honor for me to be asked to assume the responsibilities associated with this post and a challenge of the first magnitude considering my strong belief in the importance of the Society in the future of world affairs. If that piece of rhetoric surprises you, then read on and hopefully you will see where I am coming from.

First, let me digress for a moment and express a few thoughts relative to the positions to be occupied by Carolyn and Keith in the history of universal humanity. The Hensons and I were present at the dinner gathering at Princeton University in May of 1975 when several people came to the open microphone provided for general comment and expressed the need for an organization, something to bind those of like mind and purpose. I wanted to coordinate research; others wanted a conduit for information on developments in space colonization; still others wanted information on productive political action. Keith and Carolyn Henson took it as a challenge of significance so great as to permeate their very existence. Money **earmarked for personal belongings such as furniture and automobile repair and** purchase was expended on creating and nurturing the L-5 Society. Personal sacrifices of long hours spent at nights and on weekends working on correspondence and getting the early versions of the **News** out (never missing an issue and always on time, by the way) were recognized by only a few. Then there were the massive telephoning campaigns to try to raise enough money to cover some key congressional hearing or support the fight against an unfortunate stand or action taken by those ignorant of our goals and purpose. Many questioned their tactics, some questioned their motivations; but no one has ever questioned their dedication and hard work. And history will record that they accomplished something unique in the history of humankind; they created an organization whose membership cuts through all boundaries and represents all walks and bents. The petty differences that spring up between factions in a closed system are as common and natural as birth and death in the universe. In environment, energy, education, resources, government, and other fields we have witnessed the growth of an ever expanding number of individual viewpoints and their attendant organization. I suspect, from my wanderings and meetings with people, that there are a large number of these viewpoints represented within our Society, in peaceful coexistence with diametrically opposed views. Why? Because they all recognize one indisputable fact; humanity must have an open system, one that allows, indeed one that *promotes* human freedom. And again, Carolyn and Keith are at the forefront, fighting a proposed treaty that for all intents and purposes outlaws individual self-determination beyond the near orbits of the Earth.

Dear Gerry,

Congratulations on your election to the Presidency of the L-5 Society. It was an excellent choice on the part of the Society's Board of Directors.

You and I have had a number of opportunities during the past five years to work closely together, and on those occasions your technical expertise, your good judgment, and your ability to work smoothly and cooperatively have all been very much in evidence. Those qualities will all help now to bring the Space Studies Institute and the L-5 Society closer together, an evolution that is to be welcomed. As you know, the Institute is dedicated to the support of vital research into space manufacturing and the human movement into space.

With all good wishes,
Sincerely,
Gerard K. O'Neill
Professor of Physics
Princeton University
President, Space Studies Institute

New L-5 President Gerald Driggers

Now I am to be given an opportunity to do what I wanted; to coordinate and encourage research and promotion of the humanization of space. I accept my nomination by Carolyn Henson, Peter Vajk and Mark Hopkins and my selection by the Board of Directors as a mandate to act upon this opportunity. Thus at this point I will turn my attention to the future in this first of an open-ended series of monthly columns by the President of the Society.

Within our Society today are the seeds of the greatest organization in history. Why? Because we offer hope; hope for a bright future for current and succeeding generations; hope for beneficial growth in freedom, wealth, harmony, health and joy. Are these the words of the quiet, technical, pragmatic (indeed *DULL*) Gerald Driggers known to many of you? Yes, they are. And because I have been technical and pragmatic for almost 12 years these comments are not loosely made or simply articles of faith. For 11 years I have **examined the justifications for a United States space program within the context of all the common buzz words such as "spin-**off," cost-benefit, technology drivers, foreign competition and public services. These are all terribly important and form a large part of the justification sought; but, although they are necessary, they are not of themselves sufficient. The key missing elements in this panoply are the "simple" human values: hope, freedom, health, harmony, joy and, indeed, faith. These concepts encompass the fundamental motivations for new frontiers and exploration; the need for an open system instead of a closed one; the necessities of individuality. We have spent 10 years addressing ourselves to the wealth and economics issues, with token attention to the real forcing functions of civilization's advance. Don't get me wrong; economics are an absolutely essential element of humanity's expansion into the universe, but that is not really why we are *interested*, and in future issues of the **News** this concept will be considered in substantial detail.

So, where does all this bring us? Well, first, for those of you who have feared that a technologist at the helm might negate consideration of other issues, be at ease. The L-5 Society is an organization of the whole, literally and figuratively. And that is why we can become the greatest organization in human history. We allow for all aspects of the human interest in the establishment of humankind's first permanent foothold in space. We are an organization of the people and our voice will be viewed by those in authority as the responsible expression of the public will, not the "expected" pronouncements of special interest groups such as the aerospace industry. This is a grave responsiblity we carry and much work will be required before we are worthy and capable of exercising it to its fullest. In some quarters our Society is viewed as a reactionary group to be scorned and avoided; in others it is regarded as simply a nuisance. To some we will always be these things and the steps necessary to overcome such mindsets would surely destroy us. In many important sectors, however, we are viewed as the necessary cutting edge of space goal planning, and as a potential political force of significance. Through the coming months and years we will be striving to minimize the former views and accentuate the latter.

Here, in the broadest terms, is how I hope, in close cooperation with the Board of Directors, to achieve these expectations.

First, we are going to establish the goals of the Society in the long range and near term in a fashion which allows focus for activity and advocacy. However, the establishment of these goals requires that the Society have a clearly defined statement of purpose which may be composed of a single or several purposes.

Every member of the Society should participate in this activity by sending in no more than *three* double-spaced typewritten or six handwritten pages to our Tucson office to arrive before the end of January expressing your views on Society goals. Please understand that such limits are necessary to make this a feasible project in an organization of over 3000 people. After review of the input and Board action the results of the survey will be published n the **News.** This activity will also form the basis for much of our future action within the Society, so speak now!

Secondly, we are going to put everybody to work who wishes to work for the accomplishment of the stated goals. All interests will be represented and projects suitable for individual, group and Chapter action will be available. *This will not happen overnight.* Some projects of significance are already coming into existence such as the **Textbook Project** discussed elsewhere in this issue. Others will evolve in the relatively near future. The fully organized slate of activities will take months to bring into existence. So, my next request from each of you is a proposal on what you or your group would like to do or see done as a Society project over the next one to three years. Now again the necessary limitation: do not exceed one half typewritten page per proposal (or one handwritten page), or we simply will not be able to deal with the volume. Don't kid yourself that every proposed project is going to be acceptable within the goals of, or constraints on, the Society, which are more numerous than is generally realized. However, when projects are selected for general Society sponsorship, those individuals or groups most closely attuned in their response to certain actions will be looked to first as active participants. This is a very large undertaking and will take time to implement, so please be patient. Progress will be reported regularly.

Third, I am going to be working closely with the leadership of other societies which have some overlapping interest with us, both related to space specifically and our goals in general. It is likely that a variety of educational institutions and groups will fall into this latter category, for example. These efforts will be directed toward building our image and influence in a constructive manner. Joint conferences and projects around the country are activities which intuitively can be undertaken at every level of the Society with very positive results. Information on how to approach organizing and executing such joint activities will be made available over the next few months.

Fourth, the bylaws of the Society will be revised as has been previously planned. The Bylaws Committee is already in existence and active. Progress in this area will be reported in the **News** as developments take place.

Fifth, a membership campaign to promote the growth of the Society and its influence is going to be instituted. This will hopefully occur in the spring after deliberation over goals and bylaws is complete or near-complete. Hopefully, this campaign can be conducted in conjunction with projects undertaken within the Society or in cooperation with other organizations. It is imperative to the health and vitality of the Society that it grow steadily over the next few years. It is also, I believe, important to the future of the United States and the world that we grow, in order that the message of a hopeful future can be spread and key

Friends Reflect on the Presidency

Stuart Brand, Editor, **CoEvolution Quarterly**

To me, the Hensons' forming the L-5 Society was an enormous relief. It let me point the people asking about space colonies at someone else. The L-5 Society gave people a place to go who were excited about space, one that gave something back if you got involved.

⁂

Charles Sheffield, President, American Astronautical Society

Carolyn seemed able to work at Society matters when surounded by things that would stop me completely. Working with a telephone in one hand, a nursing baby in another, while writing with a third, and somehow running a household is an impressive juggling act. As a society's president I know that getting hundreds of people active enough to write their congressmen and stuff envelopes is an enormous task. A society absolutely has to have someone like Carolyn to get people involved and keep them in tune.

⁂

Richard Johnson, Administrator, 1975 NASA/Ames Summer Study on Space Colonization

They (the Hensons) *were extremely dynamic and politically savvy in forwarding L-5 goals. They served not only L-5 but everyone's interests in space as well. I have been very impressed.*

⁂

Philip K. Chapman, scientist and former astronaut

And the space colony movement was without form and void. And Keith and Carolyn said, "Let there be L-5." And there was L-5. And they saw it was good. — *I would hope that the end of the Henson presidency does not mean the end of Henson influence within the Society.*

influences can be exerted. I believe a reasonable goal can be to increase our membership at a rate such that our Society doubles in size at least once per year. A shorter doubling time is achievable and desirable. A grassroots organization such as ours can command considerable attention during the 1984 election year if we start work now. We have the basic knowledge and tools to insure that the Orwellian '84 never comes to pass and the next five years provides us with our opportunity to use these tools.

Sixth, the **L-5 News** will be undergoing certain changes as yet unspecified. The **News** has been noted in the past for its high quality in articles and reporting and this tradition will be continued. It appears, however, that the opportunity to expand our circulation may present itself soon and it would be desirable to look at what options are available in format and content which would promote that expansion.

So, there are my six opening shots. New initiatives will evolve as I become more knowledgeable of the workings of the Society and the desires of the membership. Additionally, I plan to be constantly seeking new avenues by which the goals of the Society can be brought closer by action on our part. During the next few months I will be visiting as many Chapters as time and resources will allow so that we may meet and exchange ideas on a personal basis. The Society is entering a stage of maturity which will allow it to provide new services and challenges to the membership, manifested as both tools and direction for constructive action. Progress will appear painstakingly slow over the next few months as I work with the Board and several Society members to develop plans, then turn those plans into action, but I honestly believe the results will be worth the wait as we see our accomplishments and strength grow over the next several years.

A cliché of the Sixties was "Keep the faith, Baby" and we need to embrace that one just a little bit longer. But maybe there are a few clichés or slogans or something we can adopt in a few months which will be more timely and more expressive of our positive approach and goals, something like "New worlds in space mean new worlds on Earth" or "Have you seen the **Whole Universe Catalog**?" or "New Worlds in our lifetime." Well, you get the idea. Let us hear from you on such things *after* the work on goals is accomplished.

Procedurally, the address of the Tucson office is unchanged and all of the input requested above should be sent to that address for distribution to me or whomever is involved in helping to evaluate your comments and suggestions.

Let me reiterate that I consider this one of the greatest opportunities ever presented to anyone, to be asked to lead a truly dedicated organization into what will very possibly be the most challenging decade in the history of the United States. More about that in a future column. I pledge each of you my support and dedication and ask the same in return. If we pool our resources we will not simply reach for the stars, we will touch them.

Gerald Driggers, President, L-5 Society

A MESSAGE FROM THE EX-PRESIDENT

Last spring, when I realized a fourth little Henson was on its way, I appealed to the L-5 Board to help locate a non-Henson President. At first they didn't take me too seriously. After all, if I can diaper a baby while fielding a radio interview over the phone while signing a stack of thank-you letters, then all I have to do to cope with another baby is grow an extra arm, right?

Seriously, though, my husband Keith (the first L-5 President) and I handed the L-5 Board a tough job. It's not surprising that it took seven months and a close brush with the stork to come up with Gerry Driggers. Consider the qualifications demanded by Board members and the local chapters with which they consulted. When their requests were all added up, it turned out we were searching for someone with the brain of Einstein, the tact of Henry Kissinger, the sense of humor of Will Rogers and the hide of an alligator. And what could L-5 offer in return? Endless hard work, harrassment by kooks and con artists, responsibility for getting the **L-5 News** out on time and answering zillions of letters and phone calls — and a chance to make history. To make a real difference in when, and how, we reach into space.

Thank heavens Gerry Driggers accepted that challenge! Besides filling the above qualifications he has worked in the aerospace field for 14 years and written over 25 technical articles. He was active in the '75, '76, and '77 Summer Studies on space settlements and a participant in a 1978 NASA space industrialization study. Insiders at Johnson Space Center call him "a national resource."

Keith and I continue to work on L-5's behalf on the Moon Treaty fight. For the most up-to-date information on the Moon Treaty and how you can help beat it, call Keith or myself at (602) 622-8520.

The best way you can show appreciation for the work Keith and I have put into L-5 over the last four and a half years is to give Gerry Driggers your wholehearted support. He can only accomplish our goal, the large-scale industrialization and settlement of space, by enlisting the efforts of thousands of people. Working together we shall set the course of history. Reach for the stars! *Carolyn Henson*

More On *Lightsails*

From T.A. Heppenheimer, the **L-5 News** received some cautions regarding Eric Drexler's lightsail concept:

"I would like to comment on the publicity which recent issues have given to the speculations attributed to Eric Drexler, which hold that we will be able to build solar sails of particularly advanced design and performance. To quote from the May issue, 'This sail might be developed with an investment as low as $100 million.'

"In the case of these advanced solar sails, we have the speculation that they will be possible, but any estimate of developmental times or costs will be premature for a long time. We still are far from understanding their feasibility, and no one has sought or found the difficult parts of the problem, in seeking their use. In fact, all we have in that matter are some tiny samples of thin-film aluminum which allegedly are suitable for the sails."

NASA's Robert Frosch replied to these reservations and indicated the state of the agency's interest in lightsails in the following letter to the L-5 president:

"Along with a number of other people, I learned about the high-performance solar sail concept from Eric Drexler during a recent meeting at Woods Hole as noted in your letter dated June 21, 1979. Since the purpose of this meeting was to expose and discuss novel ideas for space systems and missions, Mr. Drexler's presentation was most appropriate for the occasion.

"The consensus of those present was that the high-performance sail is quite interesting and deserves more study in accord with the suggestion made by Mr. Drexler that his work should be given a rigorous review by competent specialists. NASA will conduct some form of a review, but we have not yet settled on any specific plans.

"The subject of development costs referred to in T.A. Heppenheimer's letter to the L-5 Society **News** was not discussed in any depth at Woods Hole. It is my impression that Mr. Drexler used some rules of thumb for making an estimate and would not claim to have made a detailed analysis of costs. I agree with Dr. Heppenheimer, however, that citing costs for a concept for which there is no comparable prior experience and so little knowledge is premature and, I might add, risky and unnecessary."

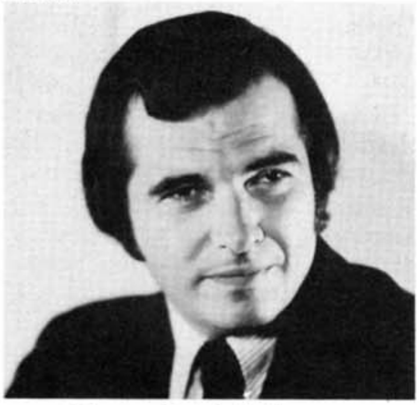
Moon Treaty Update

Learning to Make the System Work for Us: Boston L-5 Lobbies in Washington

by Chris Peterson

The call came from Carolyn Henson in Tucson: "Manpower needed in Washington, DC, at the end of October to fight the Moon Treaty!" Marcia Allen, New England L-5 President, and Eric Drexler, National Director, L-5 Society, responded by organizing a small band of L-5 activists which included Jim Mabry, Spike MacPhee, Kelly Cyr, Kevin Johnson and Christine Peterson.

We gathered for a briefing at the office of the prestigious law firm Dickstein, Shapiro and Morin. The Boston group was joined by three Washington area L-5ers: Ken McCormick (L-5's "Man in Washington"), Gary Oleson and Alex Mackay-Smith. Three staff members from the law firm were present to assist, and the briefing was given by Leigh Ratiner, a partner in the firm.



Attorney Leigh Ratiner

What followed was a five-hour crash course with no breaks on how to lobby against the treaty. I wrote frantically the whole time and have 11 pages of notes. It was clear that an immense amount of preparation had gone into this meeting. Mr. Ratiner appeared to have examined the issue from almost every possible viewpoint, and to have prepared answers to every question. His task that evening was formidable: to turn a group of well-meaning, but largely inexperienced, L-5ers into an effective lobbying force. His topic: our goals for the two days we would be in town and how to achieve those goals.

Our job was three-fold:

1. Persuade Senator Frank Church, Chairman of the Senate Foreign Relations Committee, to send a letter to the Secretary of State urging him *not* to permit US signature on the treaty before hearings could be held;

2. Persuade Representative Don Fuqua of Florida to introduce a resolution in the House condemning the treaty;

3. Persuade Representative Larry Winn of Kansas *not* to give a pro-treaty speech at the UN on Wednesday, October 31.

First we had to learn more about the treaty. Besides the five hour talk, Mr. Ratiner had prepared information packets for the legislators and a list of suggested answers to tough questions like "If the treaty's so bad, how did it get this far?" We were asked to study this material Sunday night in spite of our fatigue.

For the next two days our group, split up into teams of two or three, and guided by Leslie Rubin and Lynn Hicks of Dickstein, Shapiro and Morin visited the offices of various congressmen and talked with their staff. Our targets were the members of the Senate Foreign Relations Committee, the Senate Commerce, Science and Transportation Committee, and the House Science and Technology Committee. We had been warned to keep our presentations to the staffers down to one minute because they all were very busy with other priorities and wouldn't have time to listen any longer. We were also warned to expect the response: "The *What* Treaty??"

Imagine our surprise to find that the staffers, albeit not yet informed, were generally interested in what we had to say. Rarely did we come across one who would give us only a minute, and usually they appeared to do so *only* because they were truly very busy. (We were there during frantic work on SALT II.) My group ran across only one staffer who thought the treaty was a good one. We left most staffers interested but uncommitted, as well they might be, since the only information they had on the treaty was what we had given them. Many were able to make tentative decisions on the spot and made offers of help ranging from names of others to contact to an offer to have a Senator send a letter to all the others giving our point of view. In a few cases we were given up to an hour to make our case!

Our topic was far easier to introduce on the second day because Mr. Ratiner's efforts to get our cause into the **Washington Post** had been successful. Headlined "Would-Be Space Colonists Lead Fight Against Moon Treaty," it consisted of over 20 column inches at the top of page three which were quite favorable to the L-5 Society. We found only one staffer who hadn't seen the article; evidently everyone on Capital Hill reads "The Paper." Also on Tuesday, Mr. Ratiner appeared on an all-news radio station interview in which the interviewer obviously sympathized with our position on the Treaty.

Our results were very positive. Senators Church and Javits signed the letter to the Secretary of State asking him not to have our UN delegate sign the treaty yet. (See article in this issue.) We have the great satisfaction of knowing that the letter is an important accomplishment of permanent political significance which will affect all future negotiations and any potential battles over ratification. Besides that, Representative Winn did not give a talk to the UN on the treaty. As we left, the House resolution condemning the treaty was still up in the air. In short, our trip was *highly* successful, *far* more so than we had expected.

How could such a small group accomplish so much so quickly? The credit for this goes *entirely* to Leigh Ratiner and his staff. Without him, we would have bumbled around for two days saying the wrong things to the wrong people and accomplishing nothing. I cannot exaggerate the value of his efforts and experience to the Treaty fight and to the L-5 Society in general. However, these efforts do not come free of charge. Mr. Ratiner is a professional lawyer and lobbyist. In addition, we have had the benefits of associating with his firm, Dickstein, Shapiro and Morin: the staff's guidance on the Hill, their research, preparation of the information packets, and their fielding of questions from the congressmen. We found that the appearance of Dickstein, Shapiro and Morin on our letterhead as "Counsel and Washington Representative" immediately established L-5's credibility in Washington and dispelled any notion that we were crazies.

L-5 members owe two debts to Mr. Ratiner and his firm—a debt of gratitude of the kind we owe any very active and effective force on our behalf, and a monetary debt for their services. I believe there is no better way to repay the former than to dedicate ourselves to payment of the latter. Mr. Ratiner is worth every penny we pay him. Fund raising for this purpose should be a top priority for L-5ers.

What is the next step in fighting the Treaty? It depends on whether or not the US signs it at the UN. If it does, we will have to fight against Senate ratification. If not, we will try to have it sent back to the UN committee for re-negotiation, the ideal situation from our point of view. We must be ready to respond quickly to calls from Mr. Ratiner and National L-5 Headquarters for letters, telegrams and trips to Washington. It's fun to be on the winning side of a fight in Washington, and helping the L-5 Society establish a reputation as "the group that defeated the Moon Treaty" brings our ultimate goals that much closer.

Letter to the Secretary of State

The following letter from Senator Frank Church of Idaho and Senator Jacob Javits of New York, respectively the chairman and ranking minority member of the Senate Foreign Relations Committee, to Cyrus Vance, the Secretary of State, demonstrates two things. Prominent People share our concerns about the Moon Treaty, and L-5 members have been effective in getting their congressmen to express their concern. Our sincere thanks go to L-5 members in Idaho and New York who wrote their senators.

Regardless of your state of residence, a short note of thanks to the Senators would be appropriate. Write: Senate Office Building , Washington, DC 20510

Keith Henson

Dear Mr. Secretary:

We are concerned that the United States has apparently concurred in the decision of the UN Committee on the Peaceful Uses of Outer Space to approve the text of a draft treaty on the Moon and other celestial bodies. There are several aspects of this draft agreement which could prove damaging to our national economic and security interests, and we urge you to instruct the United States Delegation to the 34th UNGA not to support the opening of this treaty for signature as presently drafted.

The provisions of the so-called "Moon Treaty" borrow heavily from the Third UN Law of the Sea Conference. Of particular significance is the provision (Article XI) declaring the Moon and its resources, as well as all other celestial bodies in our solar system, to be the "common heritage of mankind." When the United States first agreed in a 1970 UN General Assembly resolution that deep seabed resources were the "common heritage of mankind," the phrase had no independent legal meaning. The United States position was that the phrase could only be given operative meaning through further negotiations on a legal regime for the exploitation of the seabed. Even then, developing countries claimed that "common heritage" was synonymous with "common property" so that the resources of the seabed could not be exploited by any one country or its nationals without the consent of the rest of the world.

After a decade of negotiation at the Law of the Sea Conference, the set of draft treaty articles now before the Conference sets forth an interpretation of the "common heritage" which does not conform to the national interests of the United States or of other countries with free enterprise/free market economies, particularly as they relate to such matters as production limitations, technology transfer, dispute settlement and competition with the proposed international "Enterprise." Furthermore, the formula for control of the International Authority to regulate seabed mining does not provide adequate protection for developed countries in general and the United States in particular.

We realize that the United States has taken positions in opposition to most of the objectionable portions of this text, but we remain skeptical of further efforts to extend the concept of the common heritage when the understanding of this principle on the part of many countries of the world is so contrary to our own interests. In this regard, suggestions by some participants in the LOS negotiations that Antarctica also be declared the common heritage of mankind are indications of the general trend we are confronting in international forums.

Even if the United States eventually decides not to sign—or the Senate decides not to ratify—a Law of the Sea Treaty with objectionable provisions on the deep seabed, we are concerned that the LOS negotiations could create an irrebuttable precendent for the control of all resources in non-state areas. Furthermore, while the Law of the Sea Treaty may provide protection for a number of important national interests which are unrelated to resources, the same does not appear to be true of the draft Moon treaty. Our basic freedoms in space, including on the Moon and other celestial bodies, are already protected in the Outer Space Treaty of 1967. That document also prohibits territorial or sovereign claims in outer space. Any refinements to these principles contained in the draft Moon agreement seem insignificant in comparison to the risk to our future economic interests contained in the treaty's provisions on resources.

We are concerned that the draft Moon treaty could, over the long term, be harmful to our national security interests in two ways. First, it is impossible today to predict what future economic uses might be required of lunar and celestial resources. Yet, the treaty does not even define the term "natural resources," and the scope of the term as used is so broad as to permit **arguments that it covers the atmosphere surrounding the Moon and the planets, and even the Sun's energy.**

Second, the draft Moon treaty's provisions on resources could disadvantage the United States to the benefit of the Soviet Union—which may be the reason the **Soviets first proposed such a treaty on the Moon. In this and similar forums, it has** been the apparent objective of the Soviets to erect barriers to free enterprise develop**ment of important resources. While they were unable to achieve in the Moon treaty** the moratorium they initially sought on resource-related activities in outer space, they did achieve a deterrent almost as effective—a committment to negotiate a subsequent resource regime that could serve as a practical moratorium on private investment in the interim period. (This *de facto* moratorium is probably inevitable, even if the United States successfully **preserves its legal position that the draft Moon treaty establishes no moratorium on** commercial exploitation.) The end result is that the Soviets can move forward in the area of resource development at their own pace under the guise of scientific investigation, with no fear of significant competition from the West, which must rely on its industry to provide commercial initiative. Seen from a long-term geopolitical perspective, we believe this outcome could be damaging to fundamental American security requirements.

For all of the above reasons, we urge that the United States Delegation take no action during this General Assembly to **further commit the United States to the draft Moon agreement. Indeed, we hope** that the treaty will be returned to the Committee on the Peaceful Uses of Outer Space and not opened for state signature until revised.

METALAW AND THE MOON

by Arel Lucas

Predicting that "we're about to break away from this ancestral egg we call Earth," author and producer Gene Roddenberry closed a two-day symposium on space law held at Rockwell International's Downey facility on October 27 and 28. Roddenberry's speech, in which he also stated that "this universe of ours may be a gigantic consciousness and intelligence-producing machine," was markedly different from the often closely reasoned arguments and carefully prepared historical and political presentations of the other speakers. The symposium's director, Professor Harold White of Western State University, indicated something of the meeting's importance when he privately noted that he had "lower level inquiries from most of the presidential candidates" for copies of the symposium transcript. Sponsors of "Instituting the Final Fronttier: A National Symposium on the Impact of Outer Space Activity on Law and Public Policy" were the National Space Institute, the Los Angeles County Bar Association's Section of Science and Technology and its Committee on Aviation and Aerospace, The American Society of International Law, and the American Institute of Aeronautics and Astronautics (Los Angeles and Orange County Chapters).

The 60-75 delegates in attendance heard several speakers, including California Energy Commission advisor Dan Richards, who was formerly Deputy Assistant for Science and Technology to California's Governor Jerry Brown, emphasize the immediate and long-term benefits of space development during the Saturday session. Richards, a late addition to the agenda, mentioned the various public space programs currently under consideration. These include Governor Brown's proposed 40% increase in the NASA budget, and goals which encompass a permanent manned space station with seven years to investigate metallurgy and pharmaceutical processing; Senator Harrison Schmitt's innovative ideas, which extend to a colony on Mars; and Senator Adlai Stevenson, Jr., who advocates, among other things, a type of space industrialization corporation. Richards noted that 450,000 jobs in California are directly tied to aerospace and electronics, amounting to $8-10 billion in goods and services, and that California has ridden the dips and swells of inflation better than the rest of the country. The implication is that a "healthy aerospace industry is the best protection from the recessionary forces that rip the nation from time to time." As an example of what could be done to boost the aerospace industry, he presented an overview of the Syncom satellite program developed by Hughes in 1978 which the California administration had proposed for a "free ride" on the sixth flight of the Space Shuttle. "High technology," Richards affirmed, "results in lower costs."

Gene Roddenberry jokes with fans after speech at Space Law Symposium.

—*Photo by Bob Clark*

National Space Institute Executive Director, attorney Charles Hewitt, also addressed the question of how the exploitation of energy and materials in space can be expected to generate value during his statement of the NSI's program now being presented to the government. The audience, seated almost under a full-scale mock-up of the Space Shuttle Orbiter, heard Hewitt outline the NSI's platform, which emphasizes "the creation of wealth vs. the organization of scarcity" and focuses on Earth-oriented services in order to rally support for the peaceful uses of space

Assistant General Counsel to NASA Gerald Mossinghoff answered anticipated questions about the Space Shuttle, including a brief explanation of the present and past hold-ups to the Shuttle schedule. He mentioned a fuel valve failure, the "substantial open work" needing to be done on the orbiter *Columbia* when it was delivered, and a schedule slip on the production of the external tank, as well as the installation of the thermal protection system (now back on target after falling behind earlier in the year) as being the major problems. Mossinghoff reiterated a March 30, 1980, launch even while reporting on skepticism among both NASA and industry officials about this date.

Mossinghoff's speech included remarks about NASA's attempt to indemnify its payload customers and other legal matters. When questioned about organizational changes at NASA, he replied that since the functions of space transportation, acquisition and flight of the Shuttle have been separated from Shuttle operations. NASA is looking for a new staff member. NASA administrator Dr. Frosch says that is the only management change he wants at present. Mossinghoff admitted, however, that "far-term" plans (after January 1980) were not included in his statement and that the only goal foreseeable is the "smooth-running weekly launch of the Shuttle."

The most lively discussions were over the draft Moon Treaty, which roused tempers on either side. Both positions were well represented on the panel of speakers. Dr. Carl Christol, Professor of International Law and Political Science at the University of Southern California took the "pro" position, and Dr. George Robinson, Assistant General Counsel for the Smithsonian Air and Space Museum the opposition.

A healthy aerospace industry is the best protection from the recessionary forces that rip the nation from time to time.

Dr. Robinson is an expert on "biojuridics," the legalities surrounding taxonomic discrepancies in human species. He spoke three times to the assembly, leaning heavily on L-5 lobbyist Leigh Ratiner's public presentations for his comments on the proposed treaty. Objecting to the language in the draft treaty, Robinson claimed that "the only real incentive for the United States to sign it would be basically for military purposes" since (referring to the Article XI "moratorium") the terms would deter any significant investment. "What business managers," he asked, "would invest in that kind of an enterprise?" Urging the California Bar to work to defeat the measure, Robinson said that the treaty's proponents are confusing methodology and concepts. Robinson's most interesting point about the treaty was the idea of "spacekind vs. earthkind" upon which he elaborated.

Robinson is the author of two books on the future of man in space: **Living in Outer Space**, Washington, DC, The Public Affairs Press, 1975; and **Space Trek: The Endless Migration** with Jerry Glenn, Harrisburg, PA, Stackpole Press, 1978. His major argument concerns his contention that *Homo sapiens* will change so significantly in space as to constitute a separate species. Dubbing this new entity "Homo spaciens" or "spacekind," he claimed that *Homo sapiens* has no right to legislate for another species and that present trends in policy making will only result in the same sorts of colony vs. colonial power conflicts which American history already reflects. Calling for broader perspectives in space legislation, Robinson suggested that the draft Moon Treaty be shelved or sent back to the UN for further work, emphasizing that he did see the need for some sort of legal background to space exploitation. When asked if he expected the Senate to ratify the treaty, Robinson said no.

Dr. Christol, on the other hand, based his arguments exclusively on legal points and an attack on Ratiner as an advocate of mining interests. Denying that such a thing as a moratorium exists in the language of the proposed treaty Christol nevertheless agreed with Robinson that there are no provisions for a regulatory body to be set up until after exploitation has begun. Christol apparently saw no disadvantage to this procedure, even implying that it might be favorable. Christol's lengthy discussion made it clear that it was his opinion that there would be no discrimination against or for Western or Third World Countries, that there were no disincentives to space industrialization, and that Ratiner was using "private enterprise" as a "buzzword" to frighten and arouse people.

Christol also was very definite about the provisions respecting private property in space, his statements essentially agreeing with Ratiner's and Robinson's that the proposed treaty provides that there shall be no private property of states or individuals on any celestial body. He emphasized, however, that although the language was very explicit it specified only *"in situ"* property as being "common heritage of mankind" and argued that once resources were removed they became like fish removed from a stream, the property of the resource user. His remarks also indicated that orbits around celestial bodies were also to be considered "common heritage," but he did not address the question of homesteading, which is obviously barred by these provisions.

White closed the arguments by wondering "whether or not we want to pass the treaty when we don't know what the complexion of the international regulating authority will be. It had always been a position of the negotiating team that we wouldn't okay this treaty until we knew what the complexion of the international regulating authority would be . . . . The President has not decided to recommend the treaty to the Senate although he acquiesced in the consensus process" of treaty negotiation.

Those who had come out on this sunny Sunday and sat through purely legal discussions mainly to hear Roddenberry were rewarded by a humorous, witty and imaginative discourse on "Metalaw: Context and Conclusions." Roddenberry proposed that terrestrial laws, and the quibbling and lawbreaking associated with them, be left on Earth and a new discipline, "metalaw," be invented and applied to celestial bodies. Emphasizing freedom and tolerance, metalaw would abolish boundaries, assert equal rights and carry humankind to the Stars. Roddenberry also included a few words on his new movie, "Star Trek," which he said will premiere in Washington, DC, on December 6.

Ratiner Attacks Treaty

by Arel Lucas

Aerospace Industries Association committee members heard an eloquent plea from L-5 lobbyist attorney Leigh Ratiner to stop the proposed UN "Draft Moon Treaty." The October 26 speech was given before a sympathetic audience of representatives from aerospace firms who met on the second morning of a two-day AIA meeting at Los Angeles' Airport Marina Hotel. Considering the hour—7:30 a.m.—the speech was well attended by about half the 48 representatives. Ratiner handed out both a "special report and analysis" of his own and copies of the November OMNI magazine editorial in opposition to the proposed treaty.

Ratiner's remarks focused on the similarities between the proposed treaty and the "Law of the Sea" treaty. He commented on the implications of the terms "common heritage" and "rational management" and the fact that "celestial body" is not defined by the proposed treaty. He also attacked the "moratorium" which he argued would be imposed by the ambiguous phrases which describe the setting up of a future regulatory body.

According to Ratiner, "common heritage" is usually read as "common property," and this and the lack of specifics as to what "rational management" might be will discourage industry, who "won't put money into the commercial use of outer space." He also said that the language requiring signatories to "negotiate a regulatory regime . . . can clearly be read to prohibit exploitation before international agreement is reached," thus effecting a moratorium without declaring one. Ratiner pointed out that industrial management is reluctant enough already to invest in space without further disincentive.

Another argument Ratiner presented which is not related to the actual proposed treaty itself regards a precedent set by former Secretary William Simon during negotiations for the "Law of the Sea." Ratiner said that, because of opposition from Simon's department, tax credit for seabed exploitation is disallowed, although such exploitation is internationally taxed. The attorney expected the same policy to apply to commercial uses of space.

Accusing NASA officials of saying, "It's just off in the future; it doesn't really matter," Ratiner pronounced the proposed treaty "offensive to everything good about our system," placing "a lid," "an Iron Curtain around the Earth." While admitting that even if the treaty is signed and ratified "the US Government may well be able to muscle its way into the system," he urged that the treaty be stopped now in order to avoid a ratification fight and subsequent complications. Ratiner revealed to the group his political maneuvers to have the President's consent to sign the treaty withdrawn. He claimed he had indications from the Washington *Post* and the *Journal of Commerce* that they were in opposition to the proposed treaty, and hoped to interest the New York *Times* and the *Wall Street Journal* in the fight.

Members of the group, including chairman Jim Greenwood of Learjet who introduced Ratiner and thanked him for his presentation, were attentive. Many took notes and seemed to be in general agreement with his opposition to the proposed treaty. However, they pointed out privately that no AIA action could be taken without going through the channels of advice and consent to the AIA official governing body.

Proxmire's Waterloo?

President Carter's Office of Management and Budget cut $208,200,000 from NASA's request for Research and Development funding for fiscal year 1980. Rep. Boland's House Appropriations Subcommittee cut an additional $23,000,000 from the R&D budget. But Senator William Proxmire wasn't satisfied that enough had been done to curb federal spending. When the NASA budget was marked up in his Subcommittee on HUD - Independent Agencies, he moved to cut $138,400,000 from NASA R&D. And he might have succeeded, had it not been for a save-NASA campaign by Senators Charles Mathias and Jack Schmitt.

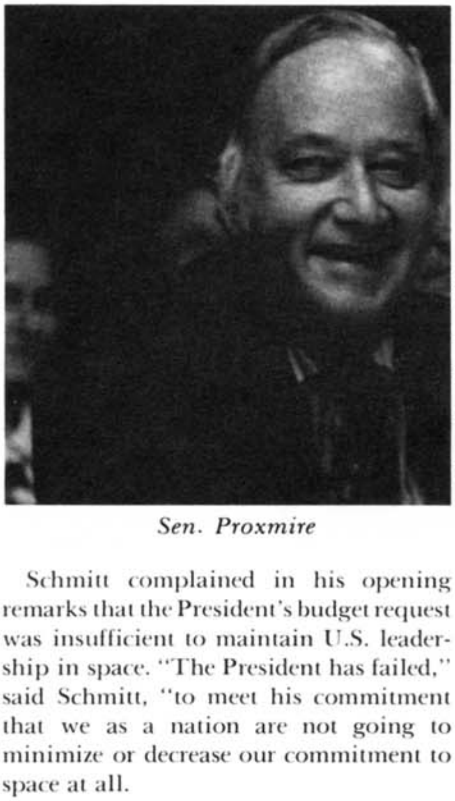
As the ranking minority member of the Senate subcommittee, Mathias has been the principal defender there of the NASA budget for several years. This year, he has been joined by the dynamic senator from New Mexico. Schmitt's scientific training and experience as an Apollo 17 astronaut have provided him with a technical expertise which Mathias has found invaluable. Despite Proxmire's powerful position as Subcommittee Chairman, the Schmitt-Mathias combination proved too much for him this year.

Proxmire's main targets were the Galileo Jupiter orbiter and probe and the Large Space Telescope. His proposed $83 million reduction of the $116 million FY 1980 allotment for Galileo would have crippled that program, and in the opinion of one Mathias aide, Proxmire would have moved to entirely kill Galileo next year if he had been successful this year. The proposed $25 million cut in the Large Space Telescope program was aimed at a one year stretch-out of the program. Mathias aides claim that a one year stretch-out of the program, although it would have reduced the federal budget by $25 million this year, would have ultimately cost the taxpayers at least $50 million extra, due to the costs of maintaining the program over a longer period of time. Proxmire would have also cut $20 million for Space Shuttle thrust augmentation, $8.4 million for aeronautical projects, and $2 million for lunar sample analysis, leaving $2 million in that program.

Proxmire had made it clear by his remarks in pre-mark-up hearings that he would move to cut the NASA budget, but the magnitude of the cuts he was to propose still came as something of a surprise. Schmitt and Mathias had been working steadily to line up votes behind their own proposal for the NASA budget. When they learned the specifics of Proxmire's plan, just one day before the subcommittee mark-up of the Appropriations bill, they redoubled their efforts.

Budgeteer vs. Expansionist

Few senators have positions on any issue that stand in more diametric opposition than the Sens. Proxmire and Schmitt on the space program. The head-on collision of these two men in pre-mark-up hearings on the FY 1980 NASA budget provided some dialogue which illuminates, on the one hand, the attitude of Proxmire, the perennial budgeteer, and on the other hand, the expansionist philosophy of the former scientist-astronaut Schmitt.



—Photo by Charles Divine

Sen. Proxmire

Schmitt complained in his opening remarks that the President's budget request was insufficient to maintain U.S. leadership in space. "The President has failed," said Schmitt, "to meet his commitment that we as a nation are not going to minimize or decrease our commitment to space at all.

> ***"I wish these kids would learn how to add and subtract and realize there are limits."***
>
> ***—Wm. Proxmire***

"There is no clear commitment in this budget . . . to rapidly rebuild our technology foundations and the economy that goes with those foundations—the economy of the future.

"I am afraid that without absent appropriate congressional action to reverse the unfortunate trends present in this and other budgets, that this NASA budget in particular would mark the beginning of an irreversible decline in this nation's development in space and aeronautics."

Proxmire: "This is going to be, I think, an interesting hearing. I am delighted that Sen. Schmitt has made the kind of statement he has, because it creates the conditions for the sharpest, clearest kind of disagreement. I couldn't disagree more with what the senator has said.

"I greatly respect Senator Schmitt. I serve with him on the Banking Committee. I know how diligent and intelligent he is . . At the same time, I strongly feel that we have to hold down spending everywhere, with no exceptions. Everywhere!"

Schmitt: "Mr. Chairman . . . again, let me emphasize my agreement with the need for an austere budget. But my concern is that as we talk about austere budgets, we remove our capability to ever build deflationary pressures into our economy.

"If we keep deferring those kinds of actions, we are never going to get out of the woods.

"That is probably the basic disagreement that we have—how to both have an austere budget and also build in deflationary pressures for the future.

"I think we have to do both."

Proxmire: "Very good."

That was the last time in the hearings that the chairman was to find anything to be "very good." The debate grew increasingly acrimonious as the hearings ground on. Proxmire was to criticize virtually every NASA program in his questions to witnesses, and Schmitt was to counter each of Proxmire's criticisms through his own questions. At times, Proxmire's complaints took on a raving quality.

The Three R's vs. "Star Wars"

NASA provides, as a part of its public information program, summer employment for youths in space projects, "career days," "summer institutes," and lecturers and educational materials for schools. When Frosch described these activities, he excited Schmitt, who frequently expresses an interest in the nation's youth, and apparently also struck a sensitive nerve in Sen. Proxmire.

Schmitt: "Dr. Frosch, one of the great benefits of the space program to date has been the stimulation that it offers in sometimes very unforeseen ways to young people. I find, more now than ever before, as I go into the school systems of New Mexico and elsewhere in the country, that teachers are using space in some very *by Ken McCormick*

imaginative ways to teach a wide variety of subjects, not just space . . . ."

Proxmire: "Dr. Frosch, if NASA is responsible for what has happened to education in this country over the last 15 or 20 years, you have a lot to answer for. As you know, in every year since 1962 test scores have gone down, not up. It is getting to be a real problem.

"Our children are being distracted by all kinds of things, including programs like 'Battlestar Galactica' and 'Star Wars.' If we are going to bring into the classrooms things that are not as relevant as learning to read and write and add and subtract and do the simple kinds of work that are essential for an educated person, it seems to me we could be in trouble . . . ."

Frosch: "I think that what we are doing is giving teachers an opportunity to use the interest and enthusiasm of students for space as a motivation for understanding why they should pay attention to physics and chemistry and arithmetic. That is the way it is cast, not as a 'gee whiz' kind of thing . . . ."

Proxmire: "I hope they do their arithmetic to the extent of understanding the costs of the space program. I criticized the notion of having a capsule containing swimming pools, golf courses and a great surburban life rotating between Earth and the Moon. I got all kinds of irate letters from young people saying this is the best way we can spend our money. I wish these kids would learn how to add and subtract and realize there are limits.

"Even though these things are attractive and exciting, we have to have other priorities."

Schmitt: "You'd better start listening to the young people, Mr. Chairman."

Proxmire: "I listen to them. Sometimes I wish I didn't have to, but I do. They vote at 18 now."

Frosch: "I hope they don't get so concerned with adding and subtracting and multiplying and dividing that they forget to have a vision of the future as well."

D

Budget Cuts vs. Increases

The HUD - Independent Agencies Appropriations Bill mark-up session saw Proxmire and Schmitt at odds again. Proxmire examined each item of the bill with respect to whether or not its dollar level exceeded the FY 1979 level. This brought another mini-lecture on economics from Schmitt: "Mr. Chairman, I hope that we can begin to draw some more subtle distinctions than whether just a dollar level goes over the budget or not, but actually look at what the different dollars do. I have tried to make that argument with respect to those expenditures which are inherently deflationary because they create new business services, versus those expenditures that are really inflationary."

Proxmire seemed not to have learned how the votes were stacked on the NASA budget issue until a brief recess for a floor vote just before the NASA budget was to be marked up. His earlier appearance of expecting a lively debate on the issue changed to a demeanor of resignation.

—Photo by Charles Divine

Sen. Schmitt

Faced with an overwhelming majority of votes against him, Proxmire could only listen ruefully as Mathias recited the terms of his proposal: full restoration of the $23 million which the House had cut, with certain adjustments to the budget to provide for the initiation of the development of the National Oceanic Satellite System and the Multispectral Resources Sampler, both important remote sensing technology programs, and to provide increases in the funding levels of research programs—the Variable Cycle Engine program and Advanced Rotorcraft Technology—and an increase in NASA's energy technology identification and verification effort.

Proxmire tried to get a cut of the $4 million addition to the Variable Cycle Engine Program, pleading that it must be an attempt to revive the Supersonic Transport. In response to the suggestion, Sen. Schmitt lectured Proxmire on aeronautic technology. He explained that VCE funding increases would provide a larger data base for understanding how advanced technology components can offer better performance with reduced noise and emissions. Futher, he explained that the research is necessary if the U.S. is to retain its position in aeronautics technology.

Proxmire was forced to capitulate. Turning to Mathias, he said that he really could not agree at all with the amendment, but, he remarked, "I recognize that you have the power . . . and the glory . . ."

"Forever and ever," chimed in Senator Bayh.

Let's hope so.

Message From Mars

This year, don't give a gift to the person who "has everything." Instead, say "Merry Christmas!" to the Space Program. The inspiration for this gift suggestion comes from the **Bay Area Chapter News**, *newsletter of the Richmond, CA, L-5.*

The "Red Planet" of Mars has always intrigued Humankind. Your fascination began with Lowellian fables of canal building civilizations, and today you are frequently tantalized by the scientific mysteries revealed by the Viking spacecraft.

Three years after their arrival here, the Viking spacecraft are still transmitting valuable information back to Earth about Martian weather, "Marsquakes," and your search for life. The remaining orbiting spacecraft will run out of propellant in March of 1980, but the Viking landers will automatically continue to send back weekly bursts of data and pictures until 1987, and possibly beyond.

Whether Viking's Martian "telephone call" is answered by waiting earthbased receivers depends more on terrestrial politics than it does on events here on Mars. The funds required to receive, process and analyze Viking's data over the next seven years is pathetically small: approximately $1 million for the total program. And the potential benefits are large; Viking's legacy will allow you to better plan for future manned and unmanned missions to Mars, thereby paving the way for a greater program of expanded planetary exploration at quite a reasonable cost. But because of funding difficulties it is by no means certain that

NASA will take advantage of this opportunity.

You do not have to rely on NASA, however. You can take the initiative. Here is your chance to have a voice in the determination of the space program. Rather than rely on notoriously fickle politicians for funds, you can help keep the huge radio dishes tracking Viking with your contributions.

You, the space enthusiasts of America and the World, can support Viking directly. Through your private donations the space program, and in particular Viking, can be kept alive. For example, if one million people such as yourself each contribute $1, then Viking's signal will be answered for the next seven years. And if such funds are raised privately, Viking's signal will bring much more than scientific data to the halls of officialdom. Private funding of Viking will be a graphic demonstration to Washington, D C, of the immense public interest that exists in the space program; an interest that is presently ignored by the decision making powers.

Mail your contributions (minimum amount $1—made payable to the Viking fund) to the VIKING FUND, P.O. BOX 7205, MENLO PARK, CA 94025. This "do-it-yourself" space program is operated by the San Francisco section of the American Astronautical Society. All contributions are tax deductible, and all contributors will receive acknowledgement of their gift, as well as an open invitation to the presentation of the Fund to NASA. The presentation will occur in Washington, D C on or before July 20, 1980: the fourth anniversary of Viking's landing on Mars.

Project Textbook

by Jerry Pournelle and Sherry McNeill

The L-5 Society enjoys a wide diversity of talents and resources among its members and chapters, but so far we haven't had many space-related projects in which members can participate. In the old days the American Rocket Society and the German VfR did hardware experiments and launched rockets. That sort of thing has become too expensive for a membership-funded organization, and even if we got funding, hardware experimentation would necessarily be confined to a small number of technical specialists.

Instead, the L-5 Board has recently approved **Project Textbook**, which is intended to involve as many L-5 members as want to work on it.

A large number of L-5 members are associated with academic institutions, either as students or as members of faculty. We should have sufficient influence to get space-related courses taught in several universities. In addition, we can encourage high schools to offer academic units in space technology as part of their science courses.

However, simple encouragement of such activities probably won't accomplish much. Organizing and arranging space-oriented courses in either the physical or social sciences is a fairly major task. There are at present few course outlines and almost no suitable textbooks. There are not many lecture notes available, and while few educators will want to use "canned" lectures, availability of organized notes and course materials can make the difference between offering a course and merely wishing that it could be done.

Project Textbook will prepare such course materials. The goal is to have packages suitable for all academic levels from high school to advanced undergraduate. They will range from surveys and overviews to technical modules suitable as the starting point for design projects assigned to senior engineering classes. We may not be able to do all of this, but given how few course materials are at present available, almost anything we generate will be a worthwhile contribution to the space effort.

The national office of L-5 already has more than enough to do with the few resources available; this project *must* be managed by the L-5 chapters, with one of the chapters undertaking overall coordination.

Chapters are therefore invited to submit proposals for **Project Textbook** activities. These should be sent directly to:

Jerry Pournelle
Attn. Sherry McNeill
12051 Laurel Terrace Drive
Studio City, CA 91604

We will then try to allocate responsibilities and resources, and keep the work going. We emphasize that if no chapter is willing to do the major coordination of this effort, it is not going to be done; we simply haven't the resources to do it ourselves. Ideally we will have several projects, each directed by a different L-5 chapter.

Members not associated with chapters are also encouraged to volunteer. We will send your papers to those chapters which seem best able to use them. We particularly want to hear from academicians at all levels; we will need a lot of advice on the kinds of materials to prepare. The purpose of **Project Textbook** is to make it easier to offer courses in space-related subjects. Any L-5 member who already offers such courses is encouraged and cajoled to help.

The work involves: choosing an accomplishable goal (such as planning a six-week high school course unit in introductory space sciences); determining what course materials will be needed; accumulating relevant published documents, and obtaining permission to reprint those which will be included in the course packages; identifying needed materials and data; filling in the holes by getting contributions from qualified experts (There are a lot of those in L-5, and in this regard, Dr. Charles Sheffield, President of the American Astronautical Society, has promised informal cooperation with this project so that we have access to another group of professionals); and finally assembling the materials into a publishable package.

Ideally, of course, a chapter should be working with an academician who will offer the course. That won't always be possible, but we must coordinate with educators. This will require interaction. We must ultimately furnish what they want, but many enthusiasts are not fully aware what they need. This is in fact a major reason why there are so few space-oriented courses.

Each major part of the project will be assigned to a chapter. The national L-5 office will support this project where necessary, but chapters should understand that they will be primarily responsible for accomplishing the work. Once a course package has been assembled, the L-5 Society will assist in final preparation, and will submit the materials to qualified experts for review of technical accuracy. We will also see that the packages are published, and encourage all members to bring their availability to the attention of suitable academic institutions.

Putting together education packages is certainly not as glamorous as firing off rockets; but the impact of **Project Textbook** could be enormous. It all depends on how much we're willing to do.

ad astra per aspera...

On Your Mark, Get Set . . .

by Annita Harlan

Very soon all you L-5 members will be receiving another SPS questionnaire. This one, like the last, is for the Department of Energy and will need *immediate reply* in spite of Christmas rush and delayed mails.

Remember the questions and comments you scribbled in the margins of the May questionnaire? Remember your hopes and fears and anger about the progress of solar power development? L-5, FASST, and CEP comments have been consolidated into 44 questions to which DOE experts are preparing answers right now. When we receive those answers in early December, they will be sent to you for instant response.

The fun part is that we must analyze and write up your responses so that DOE receives the results of this final round of communication by December 31, 1979.

How can we possibly do it? We have a two-part program. One, we are publishing the questions in this **News** issue to give you a little head start. Two, we are reminding you *now* that you can use express mail, mailgrams or telegrams (all basically 24-hour services) to send your replies.

QUESTIONS AND CONCERNS EXPRESSED BY PUBLIC REVIEW RESPONDENTS REGARDING THE SOLAR POWER SATELLITE OPTION

I. About the System

1. How stable will an orbiting satellite the size of the SPS be at GEO or could it de-orbit like Skylab, posing a danger to people on the ground?

2. How vulnerable is the SPS to partial or total destruction, especially the space segment? For example, do meteor showers pose any threat to the space segment?

3. Is there a way that rivals, unauthorized personnel, etc. can gain control of SPS?

4. What is the basis for the claim that the satellites will have a 30 year lifetime?

5. Have maintenance requirements been considered in the analysis of the reference system concept? How would maintenance be performed?

6. Will new life-support systems be required for space construction crews or is present technology sufficient?

7. What are the manpower and training requirements to build the satellite?

8. How should today's students be preparing themselves in terms of training and education so as to have a greater opportunity for more direct involvement in any future SPS undertaking?

9. Which is the cheaper reference system design—Rockwell's or Boeing's?

10. Is the DOE considering alternative reference system concepts? If so, how much money is being allocated for these studies relative to the current reference design?

II. *About the Comparative Analysis*

1. Will there be a comparative analysis of the SPS with alternate energy technologies?

2. Has a net energy analysis been done which compares the SPS with alternative energy technologies?

3. How much disruption of human settlement patterns and wild lands will the SPS rectenna system create in comparision to coal and oil shale fuel cycles?

4. Would the SPS be functional soon enough to obviate massive coal and oil shale exploitation or do the timeframes for utilization of these alternative technologies, and attendant environmental impacts, overlap?

5. Would a breakthrough on fusion obviate the need for SPS? What forms and amounts of energy would fusion energy replace that would reduce the need for SPS?

6. Wouldn't a breakthrough in terrestrial solar technologies reduce or eliminate the need for SPS? In particular, wouldn't advances in photovoltaics benefit terrestrial applications to the point where the SPS would be obsolete or comparatively uneconomical?

7. What impact will development of the SPS have on the labor market compared to alternate energy endeavors—will it be labor-intensive or capital-intensive?

III.*About the Environmental Effects*

1. A prominent concern is the microwave bio-effects. Some people want to know what happens to people and ecosystems near the rectenna should control of beam directionality be lost.

2. What are the atmospheric heating effects of decentralized solar energy systems compared to the SPS?

3. Will the SPS damage the ozone layer and create a "greenhouse" effect by heating up the atmosphere?

4. Why have only two years been allotted for atmospheric impact studies?

5. Will communications systems already in place be disrupted by SPS operations?

6. Would the current SPS reference system design create significant additional conflict over utilization of the geostationary orbit?

7. How will SPS's in GEO affect the aesthetics of the night sky?

8. Have psychological factors affecting manned operations in the space environment been taken into account in studies of the health and safety of the space workers?

IV. *About the Societal Effects*

1. Why do we need centralized power (baseload power) and a national energy grid? Wouldn't a system like SPS require too much control over people, and large institutions to manage it? Many people have expressed a desire to be more self-reliant through control of their own energy supply. Wouldn't reliance on the SPS inhibit this goal?

2. How could SPS development lead to de-centralization of social institutions and decision-making structures?

3. What are the opportunity costs of developing the SPS? Won't the diversion of so much capital to the SPS rob other promising energy technologies of development funds and leave the nation less flexible in responding to energy needs? What does the country do for its energy while it waits for the SPS to come on-line?

4. Who will be the economic beneficiaries of the SPS? The impression is that only aerospace companies and their workers will benefit.

5. Who will provide insurance for the SPS? For damage claims from occupation exposure, wandering beams and crashes à la Sky Lab?

6. There is uneasiness over the whole issue of the military implications of SPS. Some people fear or suspect that its primary purpose is as a military weapon and wonder why such studies are being done in the first place. Others wonder how vulnerable the system is to sabotage (especially the rectenna) and therefore to disruption in the supply of energy.

7. Will development of the SPS seriously deplete any of the Earth's resources?

8. Have other countries been approached to participate in SPS studies? If so, which ones?

9. Who would control, maintain and provide funds for SPS development?

10. Is a disruption of SPS power likely? What happens to an area which derives some or all of its energy from an SPS should such an event occur?

11. Is there any public awareness of the SPS as a major candidate for long-term energy generation?

12. What constituencies are being studied for their probable response to the SPS concept?

V. *About the DOE Program*

1. Why is DOE even involved in the evaluation and development of the SPS—why isn't the private sector doing this on

its own?

2. Many respondents appear to believe that the objective of the CDEP effort is to plan for the commercialization of the SPS. The actual objectives of the DOE study are not clearly understood. To what areas of investigation are the program funds being allocated? How much of the total is going to environmental studies?

3. Just how much information on the SPS is available to the general public? Has such information appeared in the media? What agencies of the federal government have information that the public could obtain?

4. How realistic does DOE consider the SPS to be?

5. On what does success of the SPS depend? How much will it cost to decide whether or not to go ahead with the SPS?

6. Can energy self-sufficiency be arrived at through the SPS?

7. Does the DOE believe that SPS development will reinvigorate the U S internally and give it a renewed position of leadership abroad?

There Oughta Be A Bylaw

The Boston and New England L-5 chapters printed an appeal to the local membership for active participation in the bylaw review process. We are reprinting Richard Shields' consideration of why bylaws are important, and the questionnaire circulated by the chapters, in order to stimulate wider interest in this significant process.

Why Are Bylaws Important?

Bylaws are to an organization such as L-5 what the Constitution of the United States is to our government. They provide a framework which permits diversity and effective individual action within the structure of clearly defined national goals. As such, it is critical that they clearly define the relationships between the divisions of the organization, and provide mechanisms for handling the ongoing activities and responsibilities of the organization and its component parts. They must be able to handle disputes without repression and must command the respect of all members of the Society.

Points to Ponder

- Dissent is good. It fosters creative thinking, experimentation and innovation, as well as developing strong, effective leaders. It must be respected and, at the same time, not be allowed to tear the Society apart. Bylaws can provide channels for doing this.

- The confederation period in United States history was, until the Civil War, the most severe challenge to the existence of this country. It resulted from an inadequate structure for handling the legitimate differences among the various regions of the country, and consequently, the country almost split into separate nations before it was five years old. The great achievement of the Constitution was the creation of a system which allowed the states to govern their own affairs while the national government carried on activities which were best handled on a nationwide basis. Essentially, it clearly defined the powers of the national government, leaving all the rest to the states. The mechanism for mediating disputes and conducting national affairs involved an ethics committee, called the Supreme Court, and a rules committee, called the Congress.

- Multiple paths to accomplish the same objective are essential. If the L-5 Society is to truly be a grassroots, democratic organization, it must include the equivalent of initiative and petition. An illustration of this is the method the ACM (Association for Computing Machinery) uses for elections. The nominating committee, which is chosen by the board of directors, nominates a slate of candidates for national office and the board. This slate is published in an issue of the **Communications of the ACM**, accompanied by biographies and statements of objectives for each candidate. If a member of the ACM feels that the nominating committee should have chosen him and didn't, he can get on the slate by having 10% of the membership sign a petition. Thus, there is the possibility of nominations from the membership at large as well as by the nominating committee.

To respond to these questions, use your own paper. Please refer to the questions by their numbers, 1-21.

BYLAWS QUESTIONNAIRE

1. What are the goals of the National L-5 Society?
2. What should the National L-5 Society do to achieve these goals?
3. What services should the National L-5 Society provide individual members and chapters?
4. What is the role of the chapters?
5. What should the chapters do to fulfill this role?
6. What services should the chapters provide to individual members and to the national organization?
7. What should the relationship be between the national organization and the chapters?
8. Should chapters be autonomous in their ability to fulfill their roles, including the raising of funds?
9. How can chapters be autonomous and at the same time responsive to the goals of the national organization?
10. How can disputes between chapters and and the national organization be settled?
11. What conditions should be required before a charter is granted to a chapter?
12. Under what conditions may a charter be revoked and how?
13. How should elections for the members of the Board of Directors and the national officers be conducted?
14. Should chapter members be required to be members of the national organization?
15. Should there be an annual national convention to which chapters send delegates?
16. What kind of financial reporting should be required of the national organization and of chapters?
17. How should the national organization be run?
18. How should the bylaws commission involve the members of the society in deliberating and reporting the issues involved?
19. Should there be a national by-laws convention to create a new set of by-laws?
20. Would you make the committment to attend if enough notice (i.e. two months) were given?
21. Where should such a convention be held?

L-5 Society, Boston Chapter
P.O. Box 162, Prudential Center
Boston, MA 02199

High Frontier Trading Post

The High Frontier Trading Post is an L-5 member service; each noncommercial member is entitled to one free ad per year, not exceeding 40 words in length. Extra or longer ads will be charged at a rate of $6.66 per column inch. Please allow 3-4 months for your ad to appear. All ads are subject to editorial review.

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WANTED: Wife (legal) for family-making —nonsmoker, nondrinker, age 18-30, L-5 eager, values survival/health not possessions; mixed racial genes (or otherwise), country-loving; Australian/N.Z. citizen preferred. Airmail: Dave Krouse (Writer, Inventor, Farmer). Box 1208, Dunedin, New Zealand.

NEWS BRIEFS

A $25 million dollar appropriation to fund solar power satellites was OK'd by the U.S. House of Representatives by a vote of 201 to 146 on Nov. 16th. The bill has not been introduced in the Senate, however.

Five of the fifteen members of the Senate Foreign Relations Committee have committed themselves in writing to oppose the "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies." They are committee chairman Frank Church (D-ID), ranking minority member Jacob Javits (R-NY), S.I. Hayakawa (R-CA), Dick Stone (D-FL), and Richard Lugar (R-IN). No member of the committee has yet come out supporting the treaty. If only three more members of the committee join the antitreaty forces they will be able to block the Moon treaty.

Opposition to the treaty within the State Dept. grows. An internal memo argues, "Already, U.S. scientists and engineers have made imaginative proposals for the use of extraterrestrial resources in space-based industries and satellite power stations that could free future generations from the limits to growth...Yet the Moon Treaty...could close off these options to America's primary economic engines--private enterprise." The memo concludes, "The U.S. has nothing to gain from signing the Moon Treaty."

The Washington Post, Wall Street Journal and Science magazine have all credited the L-5 Society with leading the battle to block the treaty.

The Special Political Committee of the United Nations passed the "Moon Treaty" by consensus Nov. 2nd. The treaty is expected to be approved by the General Assembly Nov. 29.

Massachusetts Institute of Technology's (MIT) Dave Smith has recently completed "Extraterrestrial Materials Processing and Management of Large Space Systems," a companion study to Convair's "Lunar Resources Utilization for Space Construction." The MIT study concluded that it is "basically feasible to produce solar cells, electrical conduits and structural members in space from lunar resources."

Smith reports that, while large quantities of lunar material must be shipped into space in order to pay for the lunar operation, the initial space manufacturing plant makes economic sense even if built on a very small scale at first. Smith envisions a space factory processing lunar materials as early as the late 1980's.

"Extraterrestrial Materials Processing and Management of Large Space Systems," NASA-161293, is available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. "Lunar Resources Utilization for Space Construction," NASA-15560, is also available there.

Rice University is working on two solar power satellite contracts. Chad Gordon and Steven Klineberg of the Rice Sociology Dept. are studying societal attitudes toward power satellites. John Freeman of the Space Physics and Astronomy Dept. is conducting a $65,000 study on offshore receiving antennas for power satellite energy reception. Peter Glaser of Arthur D. Little is working with Freeman on multiple uses of an offshore receiver such as aquaculture, while Don Hervey of Brown and Root is developing the structural design. They are considering a rectenna site 30 km south of Martha's Vineyard to service the New York/Boston region.

Advantages of an offshore rectenna, says Freeman, are that it eliminates land acquisition and population displacement, and keeps microwaves away from populated areas.

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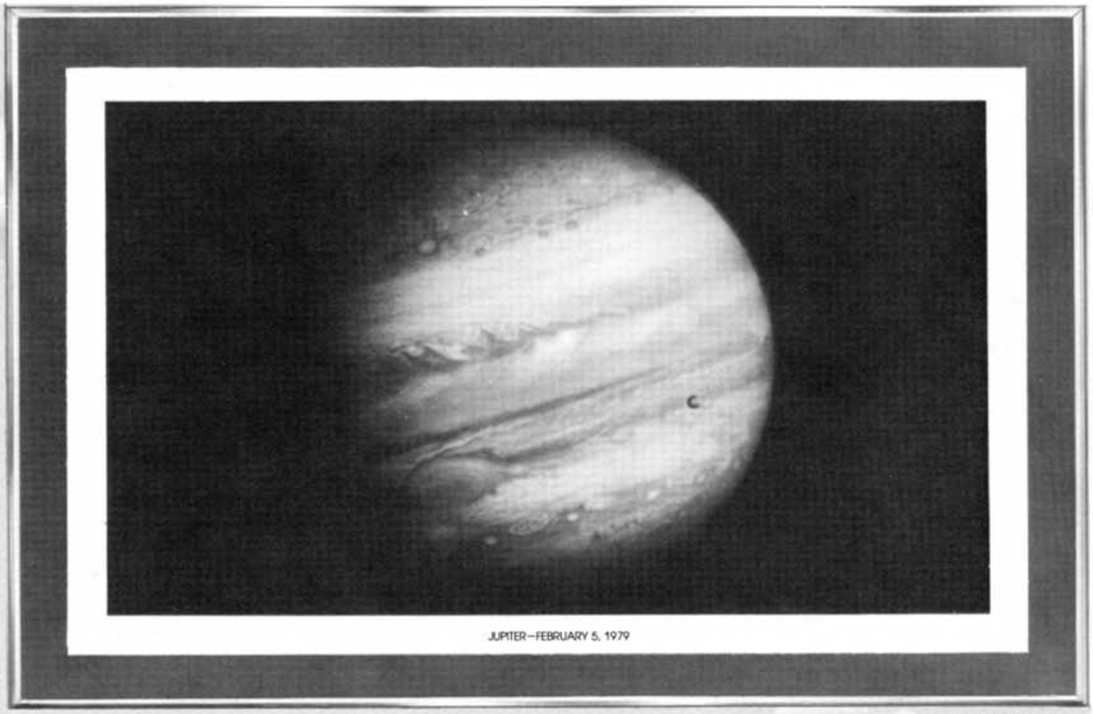

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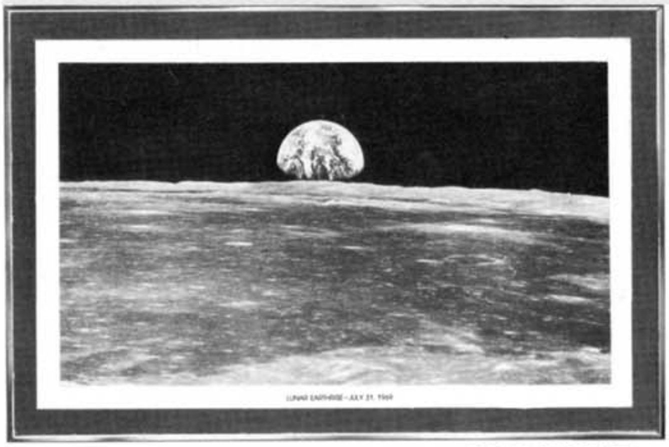

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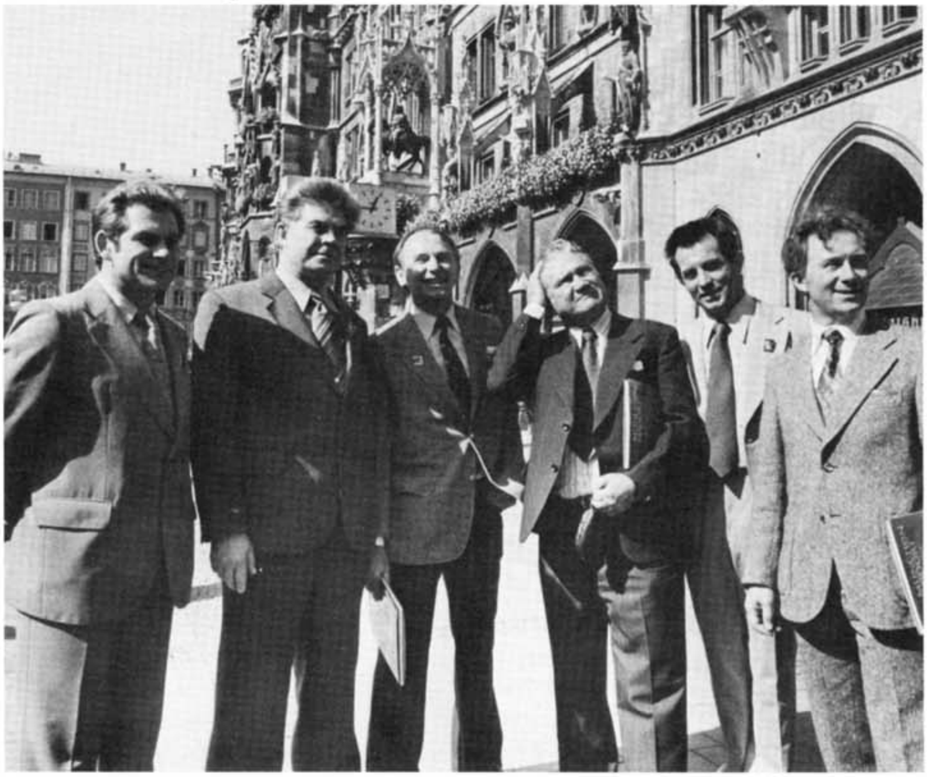
XXXth IAF Congress:

"Future of Mankind" Has a Russian Flavor

by Frederick H. Osborn, Jr.



—Photo courtesy of Suddeutsche Zeitung

Gathered on the Marienplatz in front of Neue Rathaus are, left to right, Cosmonaut Vladimir Kovalyonok, Chief Cosmonaut Georgi Beregovoy, Astronaut Alan Bean, Cosmonauts Anatoli Filipchenko, Alexander Ivanchenko and Sigmund Jaehn.

The XXXth Congress of the International Astronautical Federation took as its theme "Space Development for the Future of Mankind." It was held September 16-22 at the Deutsches Museum in Munich, West Germany.

There were 980 recorded participants from 36 nations. As could be expected, the largest number, 324, came from the host nation, the Federal Republic of Germany. There were 245 from the United States, 62 from France, 26 from the Soviet Union and 67 from other communist countries, 37 from Great Britain, and 30 from Japan. The XXXIth Congress will be held in Tokyo in 1980.

Of the 10 original founders of the IAF, Dr. Teofilo Tabanera from Argentina, Prof. Dr. -Ing. Hermann Koelle from West Germany, Arthur C. Clarke from Great Britain, Dr. Ake Hjertstrand from Sweden, and Ing. Hans-Joachim Ruckert from Austria were present, grayer, but as full of life and enthusiasm as ever.

A great many papers were highly technical. While all were undoubtedly useful, many suffered in presentation. The Soviets, in this correspondent's opinion, came away with the gold medals. Though few in number as compared with their large representation at the XXIXth IAF Congress in Dubrovnik, Yugoslavia, in 1978, they made up in quality what they lacked in quantity. They did not suffer the technical difficulties of their presentations at the XXIXth Congress.

During the past year the Soviets have done more than any other nation to extend the ability of people to live and work in space. Their Cosmonauts were present to prove it. Chief Cosmonaut Georgi Beregovoy, and his colleagues Anatoli Filipchenko, Vladimir Kovalyonok, Alexander Ivanchenko, Miraslaw Hermaszewski (Poland), and Sigmund Jaehn (East Germany) were ubiquitous, patient, agreeble, enthusiastic, admirable.

There seems to be a fundamental difference between the Soviet approach to space and our own. The U.S. seems committed to large-scale scientific efforts to obtain and organize data from which knowledge can be derived. The USSR seems committed to showing that present knowledge can be used to enable people to live and work on the new frontier.

Thursday, an audience of several hundred gathered to enjoy a film promised by the Soviet Cosmonauts. Dr. -Ing. Walther Rathjen, Curator for Aeronautics, Astronautics, Navigation and Oceanography of the Deutsches Museum, introduced the film. It is called, roughly translated, *Cosmos, A Long Way*, has an all-Russian commentary, and an impressive musical score. It runs 45 minutes, is in color, and competently edited in the worthy tradition of Eisenstein and Pudovkin. The film showed planning and management committees in session, Cosmonauts in training, the Soyuz spaceship being assembled, supplies being prepared and delivered, the control room, the Vostok launch, superb shots of docking and marvelous views of the earth from Salyut 6. But the best shots were those of work and repartee in the space ship in orbit; water bubbles floating about, a space-suited hand picking up a pencil to write a note, going through an airlock for EVA, welcoming visiting Cosmonauts, exercising, and kidding in orbit, landing in Siberia, and an unforgettable shot of two Cosmonauts lying like damp dishcloths in front of a descended capsule smiling gamely through the visors of their space suits. To a lay observer the film was overwhelming in its frankness and realism. This was the beginning of a way of life untethered to the apron strings of Mother Earth. Attempts are being made to secure a copy to show scientific groups in the US.

The Soviets would like to see humankind expand into space. They have taken major steps in that direction, and, at this Congress they were able to communicate a portion of the psychological and technical armamentarium which undergirds their endeavours. Interplanetary space has energy and resources beyond imagining. If the Soviets keep on learning as fast as they have about piloted space flight, space processing of materials, and space industrialization, and if we are not able to get our space program moving again, then Shuttle or no Shuttle, we had better learn Russian if we want a piece of the action. Carter, Mondale, Proxmire, Frosch, OMB and the rest take note!

There were two full sessions on space processing of materials, at which 16 papers were scheduled. None were American. Professor Gerard K. O'Neill's excellent discussion of mass drivers in an impressive session he chaired with H.O. Ruppe of FRG and the accompanying papers on obtaining and processing lunar and asteroidal materials were all ground-based and theoretical. No one knows whether the ideas will work in space until we get there.

There were sessions on Advanced Systems, Communication Satellites, Bioastronautics, Earth and Ocean Observations, Propulsion, Astrodynamics, and the History of Astronautics. There was a magnificent current events session with NASA's most recent photos of Jupiter and its moons, which were spectacular.

Gloria Heath of SAR-ASSIST, USA, chaired excellent sessions on Space Rescue and Safety, enlarging the fine body of data and practical proposals developed in previous Congresses.

L-5 Director, former Ambassador Edward R. Finch, Jr., in a paper presented previously to the International Colloquium on the settlement of Space Disputes, reported 1,032 outer space payloads in orbit, plus 3,481 pieces of outer space debris. Of the payloads 529 are Soviet, 409 American. The HSL Colloquium also met during the Congress. There was plenty to talk about, including the draft 1979 Moon treaty and whether its provisions on "common heritage of all mankind" and a possible "international regime" later do or do not impose obstacles to free enterprise exploitation of space. But there was little, as yet, for the lawyers to get their teeth into other than the Cosmos 954 incident (that Soviet satellite with a small atomic power supply aboard which fell in the Canadian wilderness. Canada is claiming $12 million damages), and Skylab's fall, which has produced no claims yet. The lawyers' time will come when energy, raw materials, and finished products begin arriving from orbit.

There were seven papers on Solar Power Satellites. Several ways of collecting energy from the sun in space and delivering it to base load utility grids at the earth's surface were discussed in detail and depth, from a "messy but necessary" route to an Intelsat kind of organization which J.M. Logsdon of George Washington University described, to a status report by Fred Koomanoff of NASA. There was an ingenious suggestion for an SPS without moving parts written by M. Pospisil of Czechoslovakia and read by Jerry Grey of AIAA.

While it was evident that solar power satellites are to be taken seriously, no one suggested that a SPS might make a contribution to the energy crisis in less than 15 or 20 years, or that a "moral equivalent of war" approach might get an SPS into space a bit sooner.

It was evident, too, that other nations are not going to stand idly by and wait for the United States to get with it. The Soviet Union, the European Space Agency (the Ariane program), and the Japanese are getting into the act.

Book and Article Reviews

Article and book reviews by Conrad Schneiker.

"Sky Farming." David Lempert, **Yale Scientific**, March 1978.

Summarizes space-grown crop yield predictions made for the 1975 NASA/Ames Summer Study's space colony design.

"The Artist and Space." James Dean, **Interdisciplinary Science Reviews**, September 1978.

The director of NASA's Art Program expounds on the program's philosophy, difficulties and rewards. Includes many illustrations of the program's artwork. Presents an insider's view of artist-engineer interactions as artists move in, around, and through the official channels of the NASA empire. Fascinating.

"Will Space Processing Get Into Orbit?" Richard S. Lewis, **New Scientist**, November, 1978.

Reviews a report by a National Research Council committee on materials processing in space. The report appears skeptical in the extreme, in spite of positive results from Skylab and Apollo-Soyuz experiments. No theoretical barriers are raised; the main faults cited are NASA's inadequate research methodology, "undue publicity," and ignoring problems that could prevent substantial benefits from space-based material processing from being practical and economical.

Space Art: A STARLOG Photoguidebook. STARLOG Magazine, 1978.

This book is an incredible collection of 192 large pages, jam-packed with colorful and striking space-related artwork. This treasure includes awesome planetary vistas, meticulously crafted renditions of space vehicles and space structures, enchanting "landscapes" of our solar system's planets and moons, and some fascinating artwork from the NASA fine arts program.

Announcements:

SPS Papers Needed

The 1980 Satellite Power Systems Program Review and Symposium has just issued an announcement and first call for papers for its April 22-25, 1980, Lincoln, Nebraska, conference. The Department of Energy and NASA, sponsors of the meeting are soliciting technical papers in four topical areas:

1. *Systems Definition*
2. *Environmental Assessment*
3. *Societal Assessment*
4. *Comparative Assessment*

Those interested in submitting papers must submit three copies of a typed, single-spaced, half-page abstract of their papers for review. These must be received, with an Abstract Submittal form, by Symposium administrators by January 15, 1980. Direct inquiries to:

David L. Christensen
Johnson Environmental and
Energy Center
The University of Alabama
in Huntsville
P.O. Box 1247
Huntsville, Alabama 35807
Telephone: (205) 895-6257

Solar Power in France

An international Symposium on Solar Power Satellites will be held in Toulouse, France, June 25-27, 1980, at the Ecole Nationale Supérieure de l'Aéronautique et **de l'Espace-Centre d'Etudes et de Recherches de Toulouse.**

The symposium is a cooperative effort of Dr. Peter E. Glaser, President of the SUNSAT Energy Council, with the French Centre Nationale d'Etudes Spatiales and Centre d'Etudes et de Recherches de Toulouse.

Session topics will include SPS systems and technology, space transportation, economic considerations, environmental effects, societal assessments, insitutional arrangements and international cooperation. French and English simultaneous translation of the sessions will be provided.

Registration and accommodation information is available from

O.N.E.R.A.-C.E.R.T.
BP 4025
31055 Toulouse Cedex
France

18th Goddard Memorial Symposium

"Commercial Operations in Space 1980-2000" **will be the theme of the 18th Goddard Memorial Symposium to be held at the Washington Hilton Hotel, Washington, D C March 27-28, 1980. The American Astronautical Society, sponsors of the event, are calling for papers, the abstracts of which must not exceed 600 words and must be received at the AAS Office, 6060 Duke Street, Alexandria, VA 22304 not later than January 1, 1980. Those interested in registration or information may use the same address or call (703) 751-**

7523. The topics on the technical program include *"Manufacturing in Space," "Earth Resources," "Communications," "Space Power Systems"* (covering solar power satellites, dynamics and control of large solar platforms, etc.), *"Commercial Launch Operations," "International Opportunities,"* and *"Research Opportunities."*

Inside the L-5 Society

Laconia Spacefair Unqualified Success

By way of an experiment, Boston L-5 reached out of the Boston area for the first time. In close cooperation with a group of active space enthusiasts from New Hampshire's Lakes Region, the Boston Chapter cosponsored a Spacefair at the Belknap Mill in Laconia, New Hampshire, October 1-6.

The alternate sponsors were a group of high technology supporters from central New Hampshire. Under the able hand of their organizer, Sherwood Frazier, a tool designer from Cambion in Pittsfield, NH, they put together a space show in celebration of the Tenth Anniversary of the Apollo 11 manned lunar landing. This show stressed the technological benefits realized from the US space program.

The program, which included 24 of Boston L-5's finest theme display boards proven in more than a dozen similar programs throughout eastern and central Massachusetts, took place in the first-floor conference area and the third-floor gallery of the Belknap Mill. The mill, a recently renovated wooldressing and textile facility, is one of New England's oldest free-standing industrial brick structures. The weeklong program included:

- Model rockets by the Estes Company
- Films
- NASA's traveling Aerospace Education Unit programs, conducted by Minot Parker, and supplied by NASA without charge for schools, colleges and civic groups.
- Displays by Frazier and his associates

The associates included: Sandy Frazier, Sam Shepard, Steve Wood, Todd Frazier, Edmund Meskys, Kevin Loiselle of Fitt's Model and Hobby Shop, Mike Bastraw, an illustrative photographer, and Larry LaFlam, a part-time graphics artist. The group:

- Set up display boards
- Modularized pictures for logical theme flow
- Performed booth duty
- Generated handouts
- Assembled press kits and teacher resource guides
- Ran movies
- Conducted tours and talked space with those who were interested.

Handout materials included a reading list assembled by the Laconia Public Library and a whole raft of L-5 material. Frazier conducted interviews for the local media, ran tours and lectures for school groups and supervised the entire show.

The displays in the conference area on the first floor were built around an eight-foot model and display module of the Space Shuttle supplied by NASA for the occasion. Another highlight of the entire event was a three-by-four foot LANDSAT photograph, red-enhanced to show vegetation, of central New England from Boston's north shore to the Vermont-Canadian border. This was generously donated by the EROS Data Center of Sioux Falls, SD.

All in all, about 1500 people came to see the Spacefair in organized school groups. Another 750 people wandered in "to see what was going on." Many young people who had seen the show during the day as part of a school science class outing came back during the evening with their friends and family in tow.

We are proud to have been involved in such a splendid event. *Raphiel Folch-Pi*

Brew From the Boston Teapot

To begin with, we would like to tell you a little about two new local chapters: MIT and Boston University. MIT L-5ers are busy trying to become a legitimate undergraduate organization. They're writing up their constitution and rounding up officers and hope to become recognized by January. Their main activity, however, is planning a program for January, MIT's independent activities period (IAP). They plan to show a series of films and sponsor several presentations on space industrialization. Also, in cooperation with NE L-5, they plan to host a panel discussion on the Moon Treaty issue.

At our recent meeting at Boston University we were happy to discover some enthusiastic students eager to form their own chapter, and in the next few months we hope to help launch them on their way! With our success at BU and MIT in forming college chapters, we look forward to starting L-5 Chapters in several other colleges.

Another important activity that involves some of our members is the Education Committee. Their work in progress includes an impressive list of activities and goals. Their research group is now busy digging out information on many aspects of space development, including histories of US and USSR space programs, and detailed statistical information on SPS, space industry and space settlement. Once they've gathered this information, they will produce comprehensive 'packets' to use for position papers and to accompany our slide program. This information will also be put into a computer data bank, now being developed, so we can have easy access to whatever specific information we want. The education committee is also developing a slide program that our members can present at local schools or civic groups, and they are planning a speakers training program so that interested members can learn to give our slide show. The committee has several other projects on line, including a media-relations program and a speakers bureau.

The high point of our very full November and December calendar is that Friday, December 28, Boston and New England L-5 are having a Christmas Party!! Join us in an evening of holiday cheer (and punch) at Marcia's place! Party starts at 8 p.m. RSVP s with $2.50/person are requested by Dec. 20 (any money left over after the party will be sent to National L-5 to support lobbying efforts). If you'd like to come to our party, please send your checks to Rosemary Shields, 78 Tahattawan Rd., Littleton, MA 01460. For more information call Rosemary at 617-486-4235 or Marcia at 617-327-9514, eves. Hope to see you there!

—Marcia Allen

Portland L-5ers Tom Billings, Patty Smith, Bryce Walden

Oregon Chapter Takes Off

A recent issue of the **L-5 News** listed several kinds of projects for local chapters, stressing the importance of making such activities interesting to members. The recently formed Oregon L-5 chapter took this advice to heart and learned that a relatively small core group (10-15 people) can effectively start a chapter and carry out the kind of projects necessary for publicity and expansion of membership.

The chapter was formed two months ago in Portland. The major consideration (besides getting into space) was to gain credibility by always presenting a professional image. After drafting local by-laws, our first project was to publicize the group well enough to attract a larger number of capable, committed members. A display table at **Orycon**, a local science fiction convention with a projected attendance of 400, would be our first target.

This seemingly simple assignment began growing almost immediately. The engineer who will be heading our research committee supplied a computer as a hook to draw people to the display tale, offering them a chance to play with it by typing in their names and addresses. A local member and businessperson obtained books for sale. We created membership packets, including a local letter of introduction. We also designed our traveling L-5 backdrop for use at the **Con** and for future speaking engagements.

After putting together such a professional display we decided we needed professional programming. Roger Arnold, Seattle L-5 Vice-president and recent author in **Analog**, graciously agreed to give a presentation based on his article. This stretched into two presentations by popular demand. We also did our first TV program on a local talk show whose hostess found the idea of space colonies intriguing and the L-5 slides great visuals.

The actual convention attendance was 600, out of which we collected a mailing list of over 200 interested persons, book and membership sales of $200 and seven new active members. The follow-up for this publicity is to be a large educational meeting with an L-5 slide presentation by David Brandt-Erickson, former president of the Bay Area chapter, now an Oregon resident and member. We will also be involving people in our next projects which include an active research committee, a local newsletter and a speaker's bureau.

The ideas we used to publicize Oregon L-5 are easily adaptable to other new chapters attempting to widen their membership. Our most important discovery was how much can be accomplished by a small group, as long as you have some talented workaholic people who are seriously planning to make it into space.

Patty Smith
President, Oregon L-5
Portland, OR 97201

Letters

Concerning your appeal for funds to campaign against the proposed space laws, I agree that they are "evil" and should be eliminated.

However, these laws or others like them almost certainly *will be* enacted, and to some extent will be enforced by bureaucracies of the future.

This suggests that it would be a mistake to commit too much funding to the bottomless pit of largely unsuccessful political campaigning while a more useful response to the threat is available.

I propose that a trust fund be established to provide legal aid and other assistance to space pioneers who run afoul of legal entanglements.

Paul Shewan
San Jose, CA

You missed the point—under the Treaty the Space "Authority" would derive total authority in space from a one nation-one vote body. No legal structure has been envisioned, indeed an appeal process has been ruled unacceptable by many participants in the treaty making process. The lawyers will have a difficult time without courts! The Treaty is more akin to a "Constitution" of space than a law.—HKH

Thank you for your recent letter (from L-5 President Carolyn Henson) concerning my efforts with respect to the draft Moon Treaty. I appreciate your support.

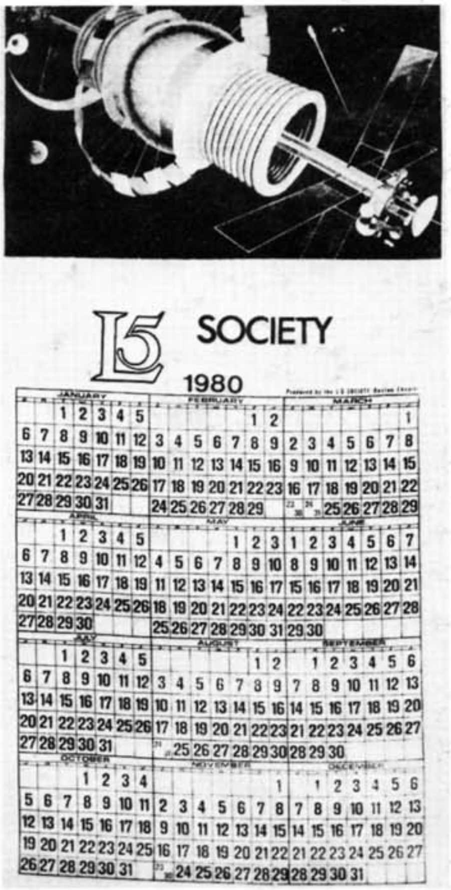
I believe that it is important that there be broader understanding of the implications of the draft treaty. Unfortunately, the Department of State chose not to consult meaningfully with the interested public and the affected industry. The Department should be criticized for this, but more importantly, a major effort should be made by those of us who are concerned about the draft treaty to make the public and the industry fully aware of what it involves. As always, constituent interest is crucial to Congressional action and, at this late stage in the process, only such action offers the hope that the Administration will not continue to pursue its present course.

I would think it appropriate for L-5 to continue contacting the affected industry and key members of Congress. For my own part, I will keep the pressure on the State Department and continue to urge my colleagues to confront this serious situation.

Representative John B. Breaux (D-LA)
Chairman,
Subcommittee on Fisheries
and Wildlife Conservation
and the Environment

It appears that we're going to have an "Apollo-type program" after all — ripping up Utah to squeeze out the oil. I say not one penny for this nutty fantasy...

Dick Fredericksen
White Plains, NY



Advertize L-5—Help The Moon Treaty Fund Raising!

Description: 1980 Wall Calendar featuring a picture of a Bernal Sphere Space Colony.

Cost: $4.00 plus $.50 postage and handling equals only $4.50.

Ordering: Send check or money order made out to **L-5 Society Boston Chapter** to:

L-5 Society Boston Chapter
P.O. Box 162
Prudential Center
Boston, MA 02199

Fund Raising: Order 25 to 99 at a cost of $3.00/calendar. Orders of 100 or more cost only $2.50/calendar! Then have each member buy five calendars at $4.00 each and resell them to friends or use them as gifts. Other non-profit organizations use this technique to raise thousands of dollars in less than a month.